The Royal London

Ophthalmic Hospital Reports,

and Journal of

Ophthalmic Medicine and Surgery.

Vol. VI. Part 1. 1867.

Part I.

Original Contributions.

OPHTHALMIC MISCELLANIES.

By Wm. Bowman, F.R.S.

No. 2.—*Cases of Zoster, or Unilateral Confluent Herpes, of the Ophthalmic Region.*

(For abbreviations, see ante, vol. v, p. 1.)

Cases of this nature have attracted my attention during many past years. The following extracts, drawn up by Mr. Rogers from my case books, are offered for the additional light they may throw on the clinical history of an affection not very much known. In connexion with them I must refer to a graphic description in the clinical lectures of Trousseau ("Clinique Medicale," 2nd edit., t. 1, pp. 192—8), and to an excellent paper by Mr. Hutchinson in the Ophthalmic Hospital Reports, vol. v, p. 191.

I have frequently seen this disease mistakenly called "erysipelas," even by accomplished practitioners. From this it is distinguished by the pain preceding the eruption, by the mingled numbness, pain, and heightened sensibility

remaining for a long period after the inflammatory outburst, and especially by its not overpassing the median line. As the nerves of sensation certainly play an important part in zoster, and the fifth is an eminent example of this system of nerves, its distribution special, and accurately known, the local form we are now considering is of peculiar interest, furnishing, probably, the one example wherein its very remarkable features may be most advantageously studied.

Zoster seems to be a peripheral disease, having its primary seat in branches of the nerves of common sensation. Probably these nerves, often from cold, become inflamed in the more superficial portion of their trunks, and in their distribution up to their ultimate network, whereupon the eruption succeeds as the result of an extension of vascular excitement to the cutaneous tissues anatomically related to this network. This view enables us to understand the pain and tenderness present in the part (usually for some days) before the skin reddens or the clusters of vesicles appear. It may explain the long-continued, sometimes lasting, alteration of sensibility in the whole region of the distribution of the affected nerve-branch, even in parts where the actual eruption may have failed to appear.

That peripheral excitement of sensitive nerves originating in a central or reflected source may induce tenderness and redness in the region of such nerves is sufficiently well known. In ophthalmic practice it is common, when an eye is intensely affected with inflammatory pain, especially if with intraocular tension the ciliary nerves are compressed or stretched, to have the whole of the same side of the head, even to the occiput—sometimes the opposite side in a less degree—not only the seat of acutest pain, but also highly sensitive to the touch, such tenderness only gradually subsiding after its cause has been relieved by (perhaps) iridectomy for glaucoma, or by excision of the globe. I have not seen zosteric eruption

thus induced, but there is an evident analogy between the two states.

Parts of the Eye Affected.—It is not always possible to examine the eye accurately during the herpetic attack, owing to the swelling of the lids; but when this subsides, it is usually easy to ascertain what tissues have suffered. I have seen nothing like herpetic eruption on the conjunctival surface of the lids or globe. The conjunctiva may be too red, the eye may be watery and intolerant of light, and the peculiar pain of the affection may be experienced in, or referred to, the organ itself; but usually there is no primary disease, such as corneal or iritic inflammation, coincident with, or forming a part of, the eruptive stage of the complaint. If these occur, they seem rather to follow after a short interval. Small softenings or ulcerations of the cornea, rather marginal than central, and slight iritis, are the more common complications, but rather the former than the latter, and they have seemed to me to bear considerable resemblance to those following small-pox, both in their course and the treatment they demand. This should be of a soothing or supporting kind, the lids being kept closed, and time being patiently allowed for the necessarily slow process of healing under natural influences. I have not found affections of the eye-ball to occur specially in those cases of ophthalmic zoster in which the eruption followed the course of the nasal branch.

Treatment of the After-pains.—I wish I could state anything very satisfactory as to the treatment of the after-pains, which are sometimes so severe as to make the patient weary of existence.

In Case IV., subcutaneous division of the nerve was only undertaken after almost all other remedies, local and general, had failed. It certainly for a time took away all feeling from the region to which the frontal nerve is distributed; and when touched in this region, the patient no longer experienced the pains which previously tormented

him. But in a few weeks the sensibility had returned, and even at first the pains in neighbouring parts to which the remedy had not extended seemed such as to make the partial relief very little appreciated. It may be also that the morbid condition of the nerve on which the pain depended was not confined to the part peripherad of the point of section, and that the central portion continued the seat of pain. Perhaps if it had been possible to divide the nerve further back, the relief would have been greater.

In Case VI., very marked relief did follow section of the nerve, and with clear evidence of the fact. When the frontal nerve was divided, the frontal pain was greatly lessened. When the external nasal branch was cut, pain was no longer referred to the skin of the nose, while the inner surface of the nostril contined to be the seat of distressing pain, and I could think of no way of dividing the inner branch entering the nostril far back through the ethmoid. The relief, so far as it extended, was in this case so permanent and considerable as constantly to elicit the patient's thanks. The result in this single case would incline me to recommend the division of the nerve, a very harmless proceeding under chloroform, whenever the after-pains are severe and continous in spite of time and other treatment.

Trousseau says, op. cit., p. 197, "I have known an old lady who, at 70, had shingles, and who, for 14 years afterwards, still suffered the most terrible pain, especially at night. Now I have under treatment a lady of 60, who for five years has been terribly tormented by the pains of herpes. I have noticed several times a singular phenomenon: the simple contact of the clothing often provokes the most unspeakable torture, and yet the skin has superficially a kind of insensibility, which lasts often long after the pains have ceased." Surely when the nerve of such parts can be reached, it must be worth while to annul its function by cutting it across.

CASE I.—*Herpes r. forehead, with Nebulous Cornea.*

Oct., 1855. Miss B., aged 40, had had herpes on the right side of the forehead in the previous June, attended with ophthalmia of the right eye, dimness of the cornea, and severe pain of a rheumatico-neuralgic character. The affection was attributed to exposure to cold winds. When seen, the right cornea was nebulous, with a streak of lead-deposit in the centre.

CASE II.—*Herpes r. forehead, with Nebulous Cornea and Iritis.*

July, 1856. Miss W., aged 57, had suffered for three years from severe inflammation of the right eye, which had left a slightly nebulous cornea. She had muscæ, flashes, and periods of temporary blindness.

She was not seen again until April, 1866, when she brought a history of confluent unilateral herpes of the right side of the forehead, in 1860, of which large scars remain. She has suffered from neuralgia of the right side of the head, eye-brow, lids, and in the eye, since the attack of shingles.

The right eye was T1, there was a dense buff nebula occupying nearly the outer half of the cornea; there were numerous adhesions of the iris to the capsule of the lens, lens clear or nearly so—Pr. $\frac{1}{10}$ and Hm. $\frac{1}{16}$. She could read J8 with $\frac{1}{10}$ and, with $\frac{1}{16}$, Snellen 70, at 10′. She had used convex glasses for thirty years. Left eye Tn., posterior synechia, pupil almost closed, no reflex from the fundus, only perception of light.

CASE III. *Herpes l. forehead, with int. Strabismus of l. and Diplopia.*

Mr. W., aged 36, was seen in March, 1858. He had had a consumptive tendency for three years. On two occasions diplopia had occurred for six weeks, and then ceased. At this time he had diplopia of four months' duration, following an attack of "erysipelas" (shingles), which had left cicatrices on the left brow, and a sensitive state of the skin. Diplopia horizontal, right image formed by right eye, and faint, the two images a foot apart at 12′. Giddiness with each eye constant. The eyes appeared straight, but the left had a slight tendency to internal strabismus, on looking to the right.

March 18, 1859. Soreness and numbness of the skin have

continued. The diplopia has increased, and there is decided internal strabismus. He always walks with one eye closed, on account of the double vision.

Division of internal rectus was suggested, but not acceded to.

CASE IV. *Herpes l. forehead and scalp, with Conjunctivitis. Division of Supra-orbital Nerve.*

Mr. L., aged 70, was first seen in May, 1862, when he had some dimness of the left eye, caused by faint striæ in the lens.

On Nov. 7, 1865, he came again with the following history sent by his medical man. In the previous July, he had one day intense pain in the right eye and forehead, followed on the next day by a spot of herpes in the centre of the forehead. In a day or two the inflammation spread to the neighbouring skin, and soon advanced over the entire right half of the scalp. The disease was considered a combination of herpes and erysipelas. Blisters formed wherever the mischief wandered, and the whole of the right half of the scalp was raised by a bluish sanious fluid. Under a liberal diet, and wine, and quinine, he slowly recovered. As the eruption disappeared the skin was found numbed, and hardly sensitive to the touch, but this condition was soon succeeded by extreme hyperæsthesia, and very intense neuralgic pain. As convalescence advanced, the conjunctiva of the right eye became inflamed. He had in October an attack of gout which for the time gave relief to the eye. On his visit in November, the skin on the side of his forehead and vertex was extremely sensitive to the touch, cold, heat, &c., and he had almost constant neuralgic pain. The cornea was clear, and the conjunctiva hardly affected. The forehead was covered with scars.

Embrocations and hypodermic injections caused no relief, but some ease was given by wearing a cap of cotton-wool.

May 9, 1866. Still constant pain. Sleeps badly, and does not bear opiates. Sensitiveness of skin very great. 16th. Supra-orbital nerve divided subcutaneously as it emerges from the orbit. There was hardly any external bleeding. 17th. Considerable ecchymosis of the upper lid, good night, without neuralgia. 19th. Still pain in side of temple and nose, but ex-

presses himself relieved since the operation. The last account received (in December) reported very little improvement, as resulting from the operation.

CASE V.—*Herpes l. cheek and temporal region, with Atrophy of the Optic Nerve.*

May, 1864. Mr. D., aged 44, was attacked in January last with inflammation of the side of his face, which was considered as erysipelas. It occupied the left half of the face, as far down as the level of the lobe of the ear, but not the ear itself, nor the nose, except about the bridge, it extended also to the left temporal region, and for a short distance above the brow—nowhere else. In ten days it had reached its worst, and for three weeks he was very ill, with much swelling of the left lids, and great pain. When the swelling subsided, the left eye was found to be blind. At the end of five weeks, when the face was well, the right knee became much inflamed and swollen—it is now $2\frac{1}{2}$ inches more than its fellow in circumference, and has been in a plaster of Paris bandage for six weeks.

Now, left upper lid tumid, and half open. Movements of the globe normal—no paralysis of the third nerve—left globe, Tn, pupil dilated, and acts only with the right retina, no perception of light—OS. clear, od. white, arteries and veins small.

Right eye perfectly good. Sensation perfect on skin everywhere.

CASE VI.—*Herpes l. side of head, cheek, nose, and lids, with Nebulous Cornea.—Division of Supra-Orbital and Infra-Trochlear Nerves.*

Samuel H., aged 55, a sailor, came to Moorfields in May, 1866. The right eye had been blind 18 years. Sight failed gradually, during a voyage to Hobart Town, without pain or inflammation. Tn. OS. atrophy of the optic nerve. In November, 1864, he was seized with violent pain shooting through the head, followed by inflammation of the left side of the head, with swelling and great pain of the left brow and cheek. It was said to be erysipelas. He was in the hospital at Point de Galle, Ceylon, for twelve months, the inflammation lasting about five months. Ever since, he had had a numb feeling of the left side

of the head, cheek, and side of nose, with great soreness to touch—hyperæsthesia—could not bear a brush to his hair. He had frequent darting, shooting pains in the left temple and side of the head. There were white scars, not deep but well-marked, on the skin of the left forehead, on the side of the nose, and on the upper and lower lids. The palpebral conjunctiva had cicatrices from old granulations. Cornea, nebulous on the lower part, and facetted about the apex. Tn. J16.

Mr. Bowman passed a broad cutting needle under the skin above the the left brow, and divided the supra-orbital nerve. A compress was applied, and there was hardly any bleeding. The operation was followed by relief from the extreme sensitiveness of the skin of the forehead, but the pain in the vertex and side of the nose continued. A fortnight afterwards, the branches of the infra-trochlear nerve were divided, and also an artificial pupil made outwards in the left eye. The pain in the skin of the nose was relieved at once, and in a few days he left the Hospital.

Sept. 28. He has continued free from pain in the temple and side of the nose, and the pain of the vertex is much lessened. The inner surface of the left nostril is extremely sensitive to the touch, and often gives him a good deal of pain. Vision, generally, improved by the artificial pupil.

Nov. 13. There is now no pain in the vertex, nor on the outside of the nose, but the inner surface continues very sensitive. He is looking greatly improved in health. He can see J12. As he is hypermetropic $\frac{1}{24}$, he wears a glass of that power, and is enabled to get about and do a little work at the Sailors' Home, of which he is an inmate.

Case VII.—*Herpes r. forehead, with Nebulous Cornea.*

July, 1866. Miss S., aged 60, had two years ago severe pain over the region of the first division of the fifth nerve, followed by confluent herpes of the forehead. She suffered extremely for three or four weeks, but was somewhat relieved by blisters behind the ears. Numbness and hyperæsthesia of the skin have remained ever since to the present time. There are patches of cicatrix above the brow, and an uneven nebulous state of the upper part of the cornea. She has frequent attacks of neuralgia also, on the right side of the head.

CASE VIII.—*Herpes r. forehead. and Infra-Orbital Region, with Iritis and Ulcer of Cornea.*

Oct., 1866. Mrs. S., aged 52, came on October 27th, with the following history, kindly given by Mr. Kelson Wright, her medical attendant.

On Sept. 28th, she had been seized with severe pain over the right brow (like clavis hystericus), accompanied with lacrymation and photophobia.

On the fourth day after, October 2nd, several patches of herpes appeared between the right brow and the root of the hair, extending to the median line in one direction, and to the middle of the temple in the other.

On the 4th a zonular redness was noticed round the cornea. The pain over the brow was very severe.

On the 6th, there was great photophobia, and the pupil was seen to be irregular.

By the 12th the patches of herpes were nearly well, but the pain continued, being much aggravated at night.

On the 20th the cornea appeared rough and hazy, sight was much impaired. The burning, stinging pain in the brow continued.

On the 27th, when Mr. Bowman first saw her, the eye was less inflamed, but the photophobia and pain remained. The cornea was clear, but at the inner and lower margin, for about $\frac{1}{4}$ of the circumference, there was an abrupt deepish ulcer. The pupil, under atropine, showed several adhesions of the iris to the capsule of the lens. The conjunctiva was a good deal injected. Tn. There were marks of the herpetic eruption over the right forehead, and a small patch over the infra-orbital foramen; none on the nose. The skin of the forehead was very painful and tender to the touch, and the patient had been suffering severely from neuralgia, especially at night, so much so that she had hardly had a night's rest during the month. She stated that she was liable to free perspiration, and attributed the attack to exposure to cold wind during a profuse perspiration. A hypodermic injection of morphia was employed that evening, after which she slept well, and continued free from pain the following day.

On the 29th the pain returned, but to a less degree.

At the latest report (Dec. 21st), the cornea was quite clear; no trace of ulceration remained. The only complaint was of irritation when warm, or near the fire, in the spots where the eruption had been; and the skin continued of a dark colour, but free from scars.

CASE IX.—*Herpes r. forehead and eyelid; Globe not implicated.*

Edward H., aged 70, was seen in December, 1866, when he stated that five weeks previously he had severe pain on the right side of the head, followed in a fortnight by an eruption over the corresponding side of the forehead. This was accompanied by tingling and numbness of the skin. These symptoms increased for about three days. The right lids were a good deal swollen, and the sight a little dim. His general health was very good. At the time of his visit the eruption had disappeared, but dark brownish scars remained, occupying the right side of the forehead, temple, and upper eye-lid, the great force of the herpetic attack seemed to have been expended at the commencement of the frontal nerve, where the scars were deeper and darker, and it seemed to have diminished in violence as it followed the distribution of the nerve. The eruption was limited accurately by the middle line of the forehead, and spread upwards amongst the hair to about the fronto-parietal suture, and laterally over the temple. The skin was numb to the touch, and at times, especially at night, the seat of tingling and smarting, relieved by the application of warmth. The pain had not been very violent, except at the outset of the attack. The right side of the nose also was numb, although there had not been any eruption on it. The sensation of the rest of the face was normal. His vision was unaffected.

Feb., 1867. Numbness continues, and tingling at times at night, now aggravated by heat. Slight tinea of upper lid.

This case is illustrated by the annexed photograph, taken by Mr. Ernest Edwards about six weeks after the attack.

Ernest Edwards, 20, Baker Street, W

SCARS AFTER HERPES FRONTALIS.

No.	Sex.	Age.	Side.	Region.	Nerves.	Pain or Numbness.	Complications.
1	F.	40	R.	Forehead.	Frontal.	Neuralgia, severe.	Ophthalmia and corneitis, right eye, leaving nebula.
2	F.	57	R.	Forehead.	Frontal.	Neuralgia, six years at least.	Corneitis and iritis, right eye, leaving dense nebula.
3	M.	36	L.	Forehead.	Frontal.	Hyperæsthesia and numbness.	Internal strabismus of left eye, with diplopia.
4	M.	70	R.	Forehead and scalp.	Frontal.	Intense neuralgia, hyperæsthesia and numbness, lasting.	Conjunctivitis { In this case the supra-orbital nerve was divided, with no material permanent relief.
5	M.	44	L.	Cheek, temple, and brow.	Sup. maxillary and frontal.	Great pain, not lasting.	Atrophy of optic nerve, left eye.
6	M.	55	L.	Head, cheek, nose, and lids.	Frontal and nasal.	Darting pain, hyperæsthesia, and numbness.	Corneitis, leaving nebulæ, left eye. { In this case the supra-orbital and infra-trochlear nerves were divided with considerable relief.
7	F.	60	R.	Forehead.	Frontal.	Neuralgia, hyperæsthesia, and numbness, lasting.	Nebulous cornea, right eye.
8	F.	52	R.	Forehead and infra-orbital region.	Supra-orbital and infra-trochlear.	Hyperæsthesia and neuralgia, not lasting.	Ulcers of cornea, iritis, right eye.
9	M.	70	R.	Forehead, temple, and upper lid.	Frontal.	Numbness and tingling pain.	Thickening of lid, globe not affected.

REPORT ON CASES OF CYSTS IN THE IRIS.

By J. W. Hulke.

Two cases of cyst of the iris have lately come under my observation at the hospital. One of them, which was under my own care, presented an unusual feature in being pedunculated, a circumstance which permitted the more than ordinarily complete removal of the cyst, and afforded me a very favourable opportunity of examining its minute structure. The case is as follows :—

I.—A little boy, five years old, pricked his eye with a fork. His mother thought that this had not hurt the sight. Nearly two years afterwards the eye, which meanwhile had remained quiet, became red and weak, and it was then found that he could scarcely see with it. The other eye soon became irritable, and his mother, about three months after the accession of these symptoms, brought him from Faversham to the Royal London Ophthalmic Hospital for advice, January 9th, 1867.

There was now a cyst in the anterior chamber wedged between the cornea and iris. It had a flattened oval figure; the larger end corresponded to a minute, inconspicuous scar at the temporal border of the cornea; and the smaller end partly overhung the pupil, which was contracted and circular. Towards the margin of the anterior chamber, the iris receded from the cornea, at each side of the cyst, as if pushed back by it. The cyst was so transparent that through its anterior wall two small black spots were seen in its posterior wall, in the plane of the iris; and from the edges of these spots, which could not be anything else than the uveal stratum of the iris, delicate fibres were observed to arch forwards over the front of the cyst. These fibres evidently belonged to the muscular stratum of the iris. Between the black spots and the pupil the iris was distinctly visible through both walls of the cyst, and its integrity in this situation appeared perfect. These data established two things, first, that the cyst had originated in the iris between its uveal and muscular strata; and, secondly, that it was not conterminous with the whole extent of iris covered by it, but that it

had only a limited attachment to the iris at the black spots. There was a slight degree of serous iritis in this eye, and there was sympathetic irritation in the other. The visual acuity of the injured eye was less than could be accounted for by the iritis and the obstruction of the pupil by the overhanging cyst, the reason of which was not immediately apparent.

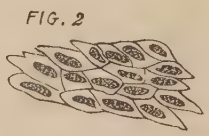
The inflammation provoked by the growing cyst demanded instant relief. The choice of measures lay between simple puncture and incision, or rather evulsion with excision of iris, as in iridectomy. In the few similar cases which I had myself seen, as well as in those of which I had read, puncture had been so commonly followed by refilling of the cyst, that I rejected it in favour of excision; because, although experience shewed that such cysts had been frequently renewed after excision, the failure might be fairly ascribed to incomplete extirpation, and I hoped that in the present case the limited structural connection of the cyst with the iris would enable me to remove it completely, and not leave any germ behind out of which a fresh cyst might be evolved.

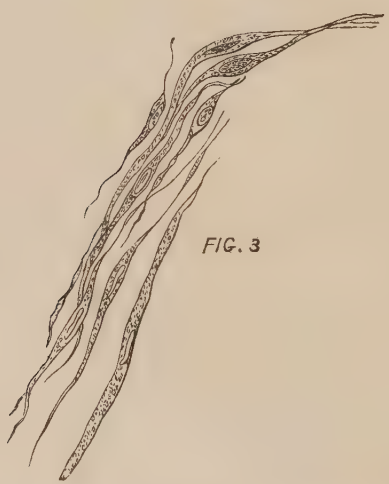
I made an incision about $\frac{1}{2}'''$ behind the anterior margin of the cornea, rather longer than the breadth of the base of the cyst, into the anterior chamber, with a broad cutting needle. In doing this I necessarily punctured the cyst, but it did not collapse, and a spurt of aqueous humour, which followed the withdrawal of the needle, protruded it in the form of a transparent vesicle through the lips of the corneal wound. It was now easily seized with a forceps and torn away.

The wound healed directly, and the iritis and the sympathetic irritation of the other eye disappeared; but as the weather was very cold, I kept him in the hospital for several days under observation.

A week after the operation I dilated the pupil with atropine, and found a ring of opaque white capsule, and the lens gone. No doubt the fork had pricked it, and it had been absorbed, but the sight of the other eye being perfect, the extent of the injury had not been recognized at the time. The cause of the diminished visual acuity was now apparent. His mother brought him again to me on 22nd May. At this time there was not any appearance of a recurrence of the cyst, and the uveal spot was the only vestige of the injury observable on the iris.

As I had never before had an opportunity of minutely examining one of these cysts, I was very anxious to do so on this occasion, and I instantly placed the cyst in a drop of glycerine upon a glass slide, held ready by an assistant. This beautifully preserved its exquisite structure, which was further brought out by staining portions of it with carmine and rose-aniline. The cyst wall was a delicate, homogeneous membrane, varying from $\frac{1}{4300}''$ to $\frac{1}{8600}''$ in thickness. Its outer surface was overlaid by a net of fusiform cells, identical with those of the contractile tissue of the iris (fig. 3); and its inner surface was lined by a pavement epithelium, the cells of which differed much in size in different parts of the cyst (figs. 1 and 2).





Figs. 1 and 2. Epithelium from the inner surface of the cyst-wall. × 240.
Fig. 3. Long spindle cells from the outer surface of the cyst-wall. × 240

This structure agrees with the description given by Mr. Bowman,* and with an observation of Professor v. Graefe's.† Since none of the elementary tissues constituting these cysts are normally present in the iris, they must, in these instances at least, be regarded as new formations, and not simply as distensions of already existing spaces, an alternative suggested by the results of Robins' and v. Kempen's examination of the debris of three cysts of the iris removed by Desmarres‡ and Bostells.§

They occur so often after wounds that the association cannot be accidental. In fifteen out of nineteen cases which I have been able to collect, as also in the two now first recorded by myself, as well as in that published in this number by Mr. Wordsworth, there was a distinct history of a foregoing mechanical injury, and this suggests the idea that in some instances perhaps the cyst may originate out of a portion of Decemet's membrane, which may have been torn away from the back of the cornea by the penetrating foreign body, and carried before it into the iris. The probability of this suggestion is lessened by the well ascertained fact that large portions of Decemet's membrane are frequently displaced into wounds and perforating ulcers of the cornea, in the cicatrices of which we often find the most intricate involutions of this membrane intercalated with portions of iris amongst the cicatricial and proper corneal tissues; and yet analogous cysts are, I believe, unknown in the cornea. It may be, however, that this coat is too dense to allow their formation. The circumstance that in most cases the formation of the cyst has not directly followed the injury, does not nullify the origin suggested, because the accession of one or more factors external to it may be necessary to

* Bowman. Lectures on the parts concerned in the Operations on the Eye. London, 1849, p. 75.

† Prof. v. Graefe. A. f. O., Bd. xii, Abth. 2, S. 228 u. f.

‡ Cases 5 and 6 in the appended Table.

§ Case 7.

rouse the germ into activity, which remains dormant while these factors are absent.

Not to take examples from general surgery, Mr. T. P. Teale's observations of the wasting of corneal leucoma, after severing an anterior synechia, make it extremely probable that traction is, under some circumstances, a very efficient agent in exciting tissue-growth; and the quick supervention of the cyst after iridodesis, which I saw in the following case of Mr. Bowman's several years ago, affords a presumption that in this particular instance traction was the exciting cause.

II.—A malt-roaster, æt. 22, struck his left eye with the point of a knife, which pricked through the lower and nasal border of the cornea, opened the anterior chamber, and produced a hernia of the iris. The wound healed, and left an interior synechia, with a minute very eccentric pyriform pupil close to the scar. Some time afterwards he came to the hospital, March 23, 1859, to inquire if anything could be done to improve the sight of the injured eye, which was much impaired. The lower half of the pupil was found to be obstructed by a mass of uveal pigment; the upper half was clear, and dilated briskly within very narrow limits; through this he could see large objects, as the hand or fingers, but could not read. Mr. Bowman made an iridodesis at the opposite point in the corneal circumference to the original wound, which converted the pupil into an angular slit. This was followed by slight iritis, and on 17th May a cyst was noticed in the anterior chamber near the scar of the original wound, and at the opposite side of the anterior chamber to the incision made for the iridodesis. It was of a subglobular figure, and it was evidently situated between the uveal and the muscular strata of the iris. Mr. Bowman tore out the cyst, and I have a note that on September 12th it had not formed again.

An examination of all the cases which I have been able to collect shows: I. That cysts, in relation with the iris projecting into the anterior chamber, originate in two situations, 1, in the iris; and 2, in connection with the ciliary processes. The first lie between the uveal and the mus-

cular stratum of the iris, and are distinguished by the presence of muscular fibres upon their anterior wall; the second lie behind the iris, and bear the uveal as well as muscular strata on their front. II. It also shows that these cysts are of more than one kind; that there are, 1, delicate membranous cysts, with an epithelial lining and clear limpid contents; 2, thick-walled cysts, with opaque thicker contents (whether these are genetically distinct from 1 we are not yet in a position to determine, but it seems probable that they are so); 3, solid cystic collections of epithelium (Case XV.), wens or dermoid cysts; 4, cysts formed by deliquescence in myxomata (Case XVIII.). III. As regards treatment, puncture, simple or combined with laceration, is so generally unsuccessful, that excision is always preferable. It is evident that the chances of success will be proportionate to the completeness of the excision, and the practicability of this will vary with the size of the cyst and the extent of its connections, and with its position in or behind the iris.

The practical application of these considerations requires the immediate excision of the cyst directly its existence is ascertained, while it is yet small, and its connections are limited, even though at the time it may not have caused any inflammatory disturbance, or any impairment of sight; because, so far as their natural history is known to us, they invariably set up finally a destructive irido-choroiditis, sometimes attended with sympathetic ophthalmia, and in the face of this the uncertainty and the immediate risks of operative interference are not adequate reasons for withholding or deferring it.

Tabular Statement of Nineteen Cases of Cysts in the Iris.

No.	Reference.	Nature of Hurt.	Time after when cyst first noticed.	Description of Cyst.	Treatment.	Remarks.
1	Tyrrell on the Eye. Vol. i, p. 368. London, 1840.	Cornea pierced by a splinter of iron, which lodged in the iris, and provoked a troublesome iritis, that left a disfigured pupil, but good sight.	Some months.	A small cyst, which gradually grew to the size of a small pea. It was attached near the pupil, and projected into the anterior chamber. Its surface was shining-white, like a delicate tendinous structure.	Removed by Mr. Scott.	The kind of operation is not mentioned. Mr. T. adds, "I believe that the patient did not retain useful sight."
2	Ditto.	The eye was struck by some bearded corn, and much inflammation followed.	A few months.	A rounded cyst, of the size of a small pea, was seated on the front of the iris, near the pupil of the right eye. It glistened like tendon.	The cyst and piece of iris on which it was seated were drawn out with a blunt hook, through a small incision at the lower border of the cornea, near the cyst. An imprudent exposure at an open window three days afterwards was followed by severe iritis and sympathetic ophthalmia. Under a mercurial treatment, she completely re-	

					covered the sight of the left eye, and partially that of the right.	
3	Wharton Jones. "Lancet," 1852, p. 569.	A prick through the lower edge of the cornea with a fork.	One year and a half.	A delicate cyst, protruding from the posterior into the anterior chamber, the lower part of the iris having been detached from its ciliary connection, and pushed upwards.	Cyst punctured by Mr. Cadge, 9th August, 1861. It collapsed, but filled again, and was punctured by Wharton Jones, November, 1861. This was followed by inflammation of the cyst, and the escape of a small quantity of yellow matter through the sclero-corneal junction.	She recovered, with perfect sight.
4	Dixon. Ann. d'Oc. T. 37, p. 141. 1857.	A prick with a fork through the sclerotic 1‴ from the lower and nasal border of the cornea.	About twelve years.	A cyst of the iris.	Punctured by Mr. Dalrymple May 20, 1846. Filled, and was punctured one month later by Mr. Dixon. August, 1848, again punctured. February, 1855, being much larger, Mr. Dixon tore it open with two needles, and then let out the contents of the anterior chamber. It filled again, and in following October, Mr. Dixon drew it out	After having been four times punctured, once torn asunder, and once pulled out, the cyst grew again, and threatened to destroy the eye.

TABULAR STATEMENT OF NINETEEN CASES OF CYSTS IN THE IRIS (*continued*).

No.	Reference.	Nature of Hurt.	Time after when cyst first noticed.	Description of Cyst.	Treatment.	Remarks.
					with a blunt hook through a corneal incision. The lens was injured, and underwent absorption, and chronic iritis occurred, leaving synechia. The cyst having again formed, was punctured Jan. 3, 1856. Four days after it was as large as ever, and in January, 1857, it nearly filled the anterior chamber.	
5	Guepin. Ann. d'Oc. T. 44. 1860. (From Desmarres Clinique.)	Discission of cataract, 27th April, 1859.	About seven months.	A large reddish-brown bilobed cyst in the lower half of the iris. Under oblique illumination both walls could be distinguished.	Desmarres drew out the cyst through an incision at the border of the cornea, and with it some opaque lens capsule, to which it adhered. In doing this an irido-dialysis occurred opposite to the wound.	Robin examined the cyst minutely. He did not find an epithelium on its inner surface, or any abnormal products, but only *débris* of the normal iris tissue.

	Ditto.	Penetrating wound of cornea, with hernia of iris.	Five months.	A bilobed bluish tumour behind a scar in the upper part of the cornea, to which the iris adhered by a single point.	Desmarres tore out the cyst through a corneal incision.	Robin did not find any epithelium on the interior of the cyst, which he regarded as formed of the tissue of the iris.
7	Bostells. Ann. d'Oc. T. 52, p. 175. 1864. (Extracted from Ann. de la Soc. du Méd.d'Anvers, September, 1854).	The absence of any scar of former wound, or trace of any other external cause, is particularly mentioned.	Probable duration more than eighteen months.	A rounded tumour, partly encroaching on the pupil, and partly hidden behind the inner part of the iris. By its opaque brown colour, it contrasted strongly with the blue colour of the iris. It adhered to, or rather formed part of, the iris, and was developed between the muscular coat, and the uvea.	Bostells drew it out through an incision at the edge of the cornea. It was very friable, and torn in pieces.	The operation was followed by sharp inflammation, and the edge of the corneal wound suppurated. Prof. Van Kempen examined the *débris*. He found only the proper elements of the iris, and conjectured that at the moment of puncture the cyst had rolled up.
8	Prof. v. Graefe. A. f. O. Bd. xii. Abth. 2. S. 228, u.f.		Probable duration more than six months.	A pretty-regular, round, yellowish vesicle in the region of the lower half of the iris, sufficiently transparent to allow a perfect illumination of its clear contents. Its convexity touched the back of the cornea; its	A linear incision was made at the side of the convexity of the cyst, so as not to injure this. Then the front wall, together with the vestige of iris coating it, was seized with a forceps, and the cyst membrane pulled	Microscopical examination showed that it was a serous cyst, with a wall composed of fine connective tissue, and a delicate internal epithelial lining; and

TABULAR STATEMENT OF NINETEEN CASES OF CYSTS IN THE IRIS (*continued*).

No.	Reference.	Nature of Hurt.	Time after when cyst first noticed.	Description of Cyst.	Treatment.	Remarks.
				posterior hemisphere seemed flatter. It measured nearly 3‴ in diameter, and 1½‴ to 2‴ thick. Its anterior wall was overlaid by the extended iris-tissue.	out. A clear, light, yellowish fluid escaped. As the last tag appeared in the wound, there was a slight resistance, due to the intimate connection of the cyst with the iris; and the operation was finished by snipping off the piece with a scissors, as in iridectomy. On the fifth day violent, purulent iritis. Little sight remained.	further, upon the anterior cyst wall, were found rarefied iris tissues, including its posterior epithelial coat, mostly deprived of pigment. Prof. v. Graefe thought it probable that the cyst proceeded from the ciliary processes.
9	Prof. v. Graefe, A. f. O., Bd. xii. Abth. 2. S. 228, u.f.	Nothing could be learned of its development.	Duration uncertain.	A serous cyst of about 2 mm. in the lower part of the iris in the tissue of this membrane. It had only moderately developed itself toward the anterior chamber, but it had pushed back the lens which was	An operation was not performed.	

				coated with the remains of the stratum of uveal pigment. Vestiges of iris tissue were also demonstrable on the front of the cyst.		
10	Ditto.	Flap operation for cataract by upper section.	Ten years and a half.	The tumour sprang from the outer and lower segment of the iris. It measured nearly 4‴, and filled the greater part of the anterior chamber; was pressed flat against the back of the cornea, and was very prominent behind. It was everywhere coated with atrophying iris. It left a small part of the pupil (which had been drawn upwards and inwards by the operation) free, and through this, with + ½ glass, the patient read No. 7 J.	None.	
11	Mr. Wordsworth. Unpublished. My Register, vol. iii, p. 151.	An arrow wound at the lower and nasal side of cornea, with hernia iridis, leav-	About eleven years.	A sub-globular, translucent vesicle, in size and shape not unlike the nucleus of the lens, at the lower and nasal	July 29th, 1866, Mr. Wordsworth tore away as much of the cyst as could be seized with a forceps, through a cor-	In the spring of this year the cyst had grown again as large as before evulsion.

TABULAR STATEMENT OF NINETEEN CASES OF CYSTS IN THE IRIS (*continued*).

No.	Reference.	Nature of Hurt.	Time after when cyst first noticed.	Description of Cyst.	Treatment.	Remarks.
		ing an anterior synechia, and a pyriform pupil.		part of the anterior chamber, attached to the iris near the synechia.	neal incision. Four days later the iris was level, and a scar was visible on its front.	
12	Mackenzie on the Diseases of the Eye, edit. iv, p. 704.	A wound.	Uncertain duration.	A small vesicle at the lower part of the iris.	Mackenzie punctured it three times through the cornea. After the third puncture it did not re-fill.	
13	Turner. Monthly Journal of Med. Science, vol. i, p. 270. 1841.		Duration uncertain.	"Passing through the pupil from the inner part of the eyeball is a semi-transparent membraneous-looking bag." The upper two-thirds of the cyst had a bluish-white appearance; the lower third was yellow, and more dense looking. The whole appeared as if filled with a thin, slightly muddy liquid, having a yellow sediment at the bottom.	Turner pushed a curved Scarpas' needle through the cyst, and divided it. The resistance was greater than he had expected.	Three-fourths of the pupil had a natural blackness; the rest was occupied by a pale whitish substance, probably the remains of the cyst. The patient saw better.

14	Combessis. Gaz. Hebdom. 1855.	Eye struck by a thin sheet of steel.	Not mentioned.	A round, opaque, whitish tumour in the blue of the eye. "Like a pearl set in the iris."	None.	
15	White Cooper. London Journal of Medicine, Sept., 1852, p. 789.	A blow, grazing the cornea. The boy had a piece of wire in his hand.	About two years.	Like a small seed-pearl. One year later a cyst of the size of a pea, lustrous, and iridescent, like a pearl.	Cooper tried to pull it out through a corneal incision, but the cyst was too hard and tough to be grasped by a canula forceps. It was as tough as cartilage, and was torn away piecemeal with a strong iris forceps. In doing this the iris was detached at its great circumference, and the cyst was seen to be attached to the ciliary ligament.	It appeared to be made up of epithelial cells so closely agglutinated that it was only after maceration that they could be separated. Recovery. Saw better.
16	Ditto.	Struck the eye against the sharp corner of a chest.	About six months.	The outer half of the anterior chamber nearly filled with a delicate, semi-transparent cyst, which pushed back the iris, and encroached on the pupil. It appeared to arise from the junction of the iris and ciliary ligament.	Punctured. Three weeks after it filled, and was again punctured. It again filled, and was then punctured and torn.	Three weeks after this no return.

TABULAR STATEMENT OF NINETEEN CASES OF CYSTS IN THE IRIS (*continued*).

No.	Reference.	Nature of Hurt.	Time after when cyst first noticed.	Description of Cyst.	Treatment.	Remarks.
17	Stoeber. Gaz. Hebdom, J. 2, p. 55.	A violent blow, 1852.	Two months.	A black spot at the outer border of the iris.—27th June, 1853. A round vesicular tumour of size of a large pea, evidently a transparent membrane containing a fluid. A few fibres of the iris were visible upon the front of the cyst.	Stoeber tried to pull out the cyst through an incision in the cornea, but failed to do so, owing to the great resistance. He, therefore, broke it up with a forceps.	December, 1857, the cyst now regained its former dimensions.
18	Richard. Gaz. Hebdom, T. 1, 1082.	Penetrating wound in infancy, leaving a white linear scar on cornea.	Patient æt 26. Four years some visual trouble.	A bilobed bluish opaline cyst; some fibres of the iris visible upon its front.	The cyst was broken up with a forceps. It was not unilocular, but a soft gelatinous mass infiltrated with a glutinous juice.	This was probably a myxoma.
19	Haynes Walton. Medical Times,	The right cornea cut with a scissors when patient was six	In patient's eighteenth year.	A semi-opaque cyst occupied upper half of anterior chamber. It was apparently attached to	Three times punctured with a needle at interval of a month. 19th July, 1854, cyst	The body of the cyst was traversed by the knife, on which a transparent gela-

Aug. 5, 1854, p. 139.	years old, after which useful sight lost.		the corneal scar, and certainly to the pupil, which it overhung.	larger. 9th August, 1854, sympathetic inflammation of left eye. Walton now pulled out the cyst with a forceps through a free corneal incision, as if for extraction of cataract through an upper section.	tinous substance escaped from it. Taylor, who minutely examined the cyst, says that it apparently sprang from a small white cicatrix in the iris, which had a fibrous structure, but he does not mention the structure of the cyst itself. V=O.

NOTE.—With reference to the case of Epithelioma of the orbit recorded by me in the last number, Mr. Wordsworth writes to me as follows, and requests me to correct in this number a misrepresentation of his views :—

"I showed it to you as a case of specific disease, but as the history of it coincided so much with an inflammatory affection, I had it explored by puncture. This only added to my conviction of its malignant nature; but, before recommending so decided a step as my opinion would necessitate, I asked Mr. Critchett and Mr. Bowman to see him. Though their opinions did not coincide with mine, I felt so satisfied that I recommended the operation, and for that purpose transferred him to you at the Middlesex Hospital, having first obtained your opinion of the case."

If I have in any way unintentionally distorted the facts of the case, or misrepresented my colleague, I frankly express my regret; but in justice to myself I must add that the published report is a substantial transcript of notes made from day to day, embodying, as I understood them at the time, the facts of the case, and the views entertained by my colleague respecting it; but as even the best of us are liable to make mistakes in diagnosis, I do not look on the acknowledgement or imputation of the fact in any difficult or ambiguous case as the slightest slur on a man's skill or experience.

May 27th, 1867. J. W. HULKE.

REMARKS ON THE USE OF A SUTURE TO CLOSE THE CORNEAL WOUND AFTER REMOVAL OF CATARACT BY FLAP-EXTRACTION.

By Henry W. Williams, M.D., of Boston, U.S.,

Ophthalmic Surgeon to the City Hospital; Vice-President of the American Ophthalmological Society.

In a prize dissertation on recent Advances in Ophthalmic Science, published at the beginning of the year 1866, I first called public attention to a modification in the operation for cataract, by bringing together the edges of the wound of the cornea by means of a suture, after extraction of the lens.

The abstract given below of 25 operations comprises all the cases treated according to this method in the City Hospital during the year 1866, and includes only those thus publicly treated; though I may, perhaps, be permitted to say that the results of cases in private practice, some of which have been watched with interest by distinguished *confrères*, have been even more gratifying (especially as regards shortening of the critical period after the operation), than those obtained at the Hospital, and in no instance, of nearly a hundred in which the suture has been employed, have I seen any harm result from its use.

The novelty of the proposed method, and the evident advantages to be hoped for, provided the fact of toleration of a suture in the cornea be once established, may perhaps excuse the publication of some details of these cases, rather than a mere general statement of their results.

The advantages claimed for this plan are briefly these: The lips of the corneal incision (and, as it seems to me, the same would be at least equally true where the incision is carried beyond the limits of the cornea), being maintained in contact, unite with more certainty by primary adhesion, and ulceration of their edges is less likely to occur.

This early cohesion of the wound greatly lessens the chance of prolapsus iridis—the danger most to be dreaded in flap extraction.

The prompt re-establishment of the anterior chamber renders it possible to make use of atropia, without fear of inducing hernia of the iris, and, by so doing, to avoid irritation from fragments of cortical substance or of capsule which may remain in the field of the pupil or the posterior chamber, thus diminishing the risk of irido-choroïditis.

The necessity for mutilation of the iris, or the repeated introduction of instruments for the removal of the lens is avoided, and flap extraction is rendered safer than some recently proposed methods, whether they are combined or not with iridectomy.

The surgeon may, if he wishes to do so, make daily examinations of the condition of the eye, with little fear of disturbing the healing process in the wound; he may instil solutions of atropia to keep up dilatation of the pupil; and, in case of the appearance of symptoms of internal inflammation, he may at once counteract them by suitable remedies.

The globe being sooner restored to nearly its normal condition, the patient may be less restricted to his bed, after the first 24 hours, and may be allowed considerable liberty of movement at an early period.

My mode of inserting the suture is as follows:—After extraction of the lens, the centre of the corneal flap is held by a delicate pair of iridectomy forceps, while a fine needle, one-fourth of an inch long, having a flat cutting point, and carrying a single strand only of the finest glover's silk, is passed through it, as near as possible to the edge. The opposite edge of the wound is then seized in the same manner, and the needle passed through at a point corresponding with the insertion of the suture in the flap. Of course so minute a needle cannot be held with the fingers, but must be passed by the aid of a needle-holder of some kind. I have used a short but strong pair of forceps, the

blades of which are roughened at their extremities. The suture is then carefully tied, and, where the silk has been waxed, a common double knot has been found sufficient, without a resort to a "surgeon's knot," so called.

The presence of the knot, although so exceedingly minute, sometimes causes slight conjunctival irritation; but far less than might have been expected, and not enough to compromise in any respect the results of the operation. Yet, after its purpose has been served, I think it best carefully to remove it, say at the end of a week or ten days after the operation. This may be readily enough done with tractable patients; but in nervous subjects it may now and then be necessary to administer ether to induce unconsciousness, before attempting it, or to leave the suture, where it gives rise to almost no annoyance, to fall of itself. In more than one instance I have seen it remain *in situ* seven weeks without inconvenience.

In all but four of the cases the extraction was done by the upper section; more recently, however, finding it easier both to insert and to remove the suture where the lower section has been made, this has been preferred.

The following general facts, applying to all the operations, are here stated, to avoid unnecessary repetition.

Complete anæsthesia has been induced by inhalation of sulphuric ether; or in a few cases, of ether reinforced with a little chloroform. This has long been my practice in operating by extraction; and, so far from observing any of the accidents which have been regarded as likely to occur during or subsequent to the anæsthesia, it has appeared to me that loss of vitreous has been less frequent where etherization has rendered the eye entirely passive, than during operations done while the patients retained consciousness, but could not control the spasmodic action of the recti muscles upon the globe. This opinion as to the advantages of anæsthesia is quite independent of my estimate of its value in facilitating the introduction of the suture, which could scarcely be safely accomplished without

its aid, but was formed and acted on long before I conceived the idea of thus holding the edges of the wound in close contact.

The dressings applied have been small compresses laid upon each eye, upon which have been placed graduated pledgets of soft lint, and these have been covered by a strip of linen or calico sufficiently long to cover the forehead and temples; the whole retained in place, without much compression, by two turns of a flannel roller.

A full anodyne has been given at bedtime, after the operation, whenever the patient seemed unlikely to sleep quietly without it, even when no pain was complained of.

In most of the cases I have made a daily examination of the general condition of the eye, and have daily introduced a drop or two of a solution of sulphate of atropia, two grains to the ounce. Perhaps, where the patient makes no complaint, inspection of the eye might with advantage be delayed till the second day. The dressings have been continued for several days; and have been applied to both eyes, whether one or both had been subjected to operation.

During the earlier months of the year, the weather being less favourable, very few extractions were done at the Hospital, and in none of these was the suture inserted. The first case for the year was on

Case I.—April 11th. Z. B., farmer, æt. 67. Right eye.

13th. Is quite comfortable. Cornea clear. Very slight injection of globe. Anterior chamber not fully established.

15th. Wound united. Anterior chamber full.

May 4. The suture has not come away, but as it caused no irritation, it was allowed to remain, and patient was discharged.

21st. Returned to Hospital, and the suture was removed (40 days after insertion). Vision excellent.

Case II.—April 18th. P. M., labourer, æt. 86. Left eye.

20th. Wound closed. Little injection. Has had no pain. Says he can see somewhat.

22nd. Can distinguish the features of a person near him.

May 14th. Suture removed, and patient discharged with good vision for large and small objects.

Case III.—May 7. J. M., Ex-Governor, æt. 73. Both eyes.

8th. Eyes look well. Has had no pain.

10th. Anterior chamber established in both eyes.

14th. Sutures removed.

June 2. A portion of capsule obstructing right pupil was divided with a needle passed through the sclera.

From this time the patient's eyes required no further attention, and though he remained in the Hospital for treatment of disease of the urinary organs, he was able to read the newspapers and to write to his friends.

Case IV.—May 25th. M. H., widow, æt. 72. Both eyes. For six days all went on well. The corneal wounds united readily, and no pain was complained of. But on 31st the pupil of the right eye was found to be filled with an exudative deposit, and much pain was felt.

June 5. The pain increasing, and serous infiltration showing itself beneath the conjunctiva of the globe and in the lids, the opaque stringy mass, apparently degenerated capsule, was removed from the pupil by means of very small forceps. This was followed by great relief, but the globe became slowly atrophied to a slight extent, with no hope of vision.

In the left eye slight prolapse of the iris occurred after the supervention of severe symptoms in right eye; but no other harm resulted than a slight displacement of the pupil, and on

Sept. 2nd the patient, who had been discharged on June 25, returned for glasses for the left eye. With + $2\frac{1}{2}$ she was able to read fine print.

Case V.—May 29th. A. H., widow, æt. 55. Right eye.

May 31st. Cornea clear. Wound closed.

June 4th. Patient etherized, and sutures removed.

June 18th. Discharged. Some threads of capsule yet remain in upper part of field of the pupil; but she has good vision.

Case VI.—June 20th. A. R., wife, æt. 77. Both eyes. The corneæ were very thin, and the globes flaccid after removal of the lenses. On this account the suture was inserted with more than ordinary difficulty, but without accident.

June 21st. Anterior chambers partially filled.

June 22nd. Wound closed; anterior chamber full.

June 29th. Sutures removed.

July 6th. With right eye can tell time by a watch with + 4. In left eye a small fragment of cortical substance still obstructs the pupil, and vision is not quite so good as in the right eye. Discharged.

Case VII.—July 6th. M. F., wife, æt. 63. Both eyes.

July 9th. Anterior chambers re-established. Cornea and pupils clear.

July 11th. Sutures taken out.

July 18th. Wished to go home to the country, and to return for glasses. Vision good with both eyes.

Case VIII.—August 16th. Rev. T. P., D.D., æt. 57. Both eyes.

August 17th. Is comfortable. Corneæ clear.

August 23rd. Removed sutures.

September 4th. With left eye reads fine print with + $2\frac{1}{2}$.

September 17th. Right pupil partially obscured by capsule. Discharged.

October 4th. Returned for a secondary operation on right eye. The capsule was lacerated, and on

October 10th. Left the hospital with excellent vision for distance with + $4\frac{1}{2}$, and for reading with + 3.

Case IX.—September 5th. E. G., wife, æt. 47. Left eye.

September 9th. Edges of wound united.

September 11th. Suture removed.

September 21st. Discharged with good vision.

Case X.—September 19th. R. B., widow, æt. 67. Right eye.

September 20th. Cornea clear. No pain.

September 22nd. Anterior chamber established.

September 29th. Suture removed.

October 15th. Discharged, well.

Case XI.—September 29th. C. S., widow, æt. 68. Both eyes.

September 30th. Patient refused an anodyne prescribed for her, and passed a most restless, nervous night.

October 1st. Complains of no pain. Wounds of corneæ healed.

October 4th. Right pupil filled with yellowish white opacity, which, after etherization, was removed with fine forceps.

October 23rd. The left pupil has become closed by an effusion of lymph, and iridectomy will be required to restore vision.

The right pupil is veiled by opaque capsule. Discharged for a visit to the country.

December 6th. The opaque capsule in right eye was freely lacerated by a needle passed through the sclera.

December 26th. The right eye is free from injection, and pupil clear. She has been highly myopic, and the fundus shows considerable changes of choroïdal structure.

Sees fairly at a distance without any glass, and reads fine print, though with some difficulty with + 4½.

The cornea and iris of left eye are in a promising condition, but another operation on this eye is deferred.

Case XII.—November 9th. J. H., locksmith, æt. 70. Right eye.

November 11th. Anterior chamber full. Very little injection.

November 14th. Dressings removed.

November 19th. Cannot yet read, but sees well at a distance with + 4½.

December 3rd. Reads with + 2½.

Case XIII.—November 15th. B. K., farmer, æt. 73. Both eyes.

November 16th. Anterior chambers full. Quite comfortable.

November 24th. Suture has come away from left and is removed from right eye.

December 7th. Sees well at distance with + 4. To wait for reading glasses.

Case XIV.—November 16th. J. L., farmer, æt. 64. Both eyes.

Has had more than one attack of irido-choroïditis, and the edges of the pupil are extensively adherent to the capsule of the crystalline. The lenses were extracted without difficulty, and the corneal wounds were healed on the second day; but some fragments of cortical substance yet remained unabsorbed in the posterior chamber. The sutures were removed on the 1st December, and patient returned home for a time. He writes that he is gaining sight, but has not yet returned.

Case XV.—December 7th. A. B., teamster, æt. 38. Left eye.

December 9th. Anterior chamber refilled. Slight injection.

December 31st. No memorandum is found of the time of re-

moval of suture or of exact visual power; but he was discharged with good sight.

Case XVI.—December 14th. D. B., widow, æt. 66. Left eye.

December 17th. Wound closed; pupil clear.

December 19th. Suture removed.

December 25th. Discharged, with good vision. To return for glasses.

Case XVII.—December 28th. S. H., widow, æt. 65. Left eye.

December 31st. Anterior chamber full. Little injection.

January 14th. Suture removed. Eye doing well.

ON THE EXTRACTION OF FOREIGN BODIES FROM THE CORNEA.

By George Lawson, F.R.C.S.,

Assistant-Surgeon to the Royal London Ophthalmic Hospital, Moorfields; and the Middlesex Hospital.

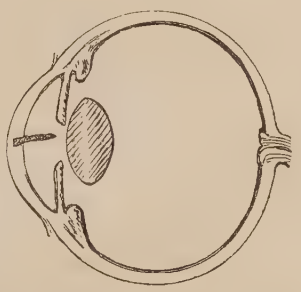
The difficulties which may beset the removal of a foreign body which has been lodged in the cornea, are well illustrated in the two following cases. On a superficial examination they closely resembled each other—in both the foreign body was a small splinter, about one-eighth of an inch in length, which had penetrated the cornea, and lodged itself so deeply that its outer extremity was buried below the corneal surface, whilst its inner end projected some distance into the anterior chamber. In both cases the endeavour to seize the foreign body from without failed, as in each it was buried too deeply to be gripped by the forceps, and any prolonged attempts would probably have forced it completely into the anterior chamber. The great difference however between the two cases was, that in the one the splinter was of iron, whilst in the other it was of wood. In the first patient I succeeded in removing the spiculum of metal by passing a broad needle into the anterior chamber, and getting the flat of the blade behind its inner projecting end, I was enabled to push the chip of metal back along the track by which it had entered, and as soon as its outer end protruded beyond the corneal surface, it was seized and drawn out with a pair of forceps by Dr. Workman, who assisted me at the operation. In the second case I at first adopted a similar proceeding, not thinking at the time that the fact of the splinter being of wood would make any material difference in the result. After introducing the broad needle within the eye, I endeavoured to force back the splinter of wood as I had done

in the previous case, but the wood had become soft and pliant, from its having been soaked in the aqueous humour, and on my applying pressure to its inner end, it at once bent up against the cornea. I was therefore obliged to enlarge the opening in the cornea made with the broad needle, and to introduce a pair of fine iris forceps within the anterior chamber, with which I seized the extremity of the thorn and drew it from the eye. In doing this the iris was slightly torn by the thorn as it was drawn over its surface; I therefore drew out the piece of iris which had been injured and excised it.

The patient recovered without an unfavourable symptom, and with the sight unimpaired.

Case I.—Andrew B., æt 28, a boiler maker, came to the hospital as an out-patient on January 10, 1867, having the previous day met with the following accident. He was punching a plate of iron when a spiculum of metal flew off and lodged itself deeply in the cornea. All the attempts made by his fellow-workmen to remove it were unsuccessful; it was too deeply buried to be easily dislodged.

On examination the eye presented the appearance represented on a somewhat magnified scale in the wood-cut. A small splinter of iron had penetrated the cornea. On looking at the eye sideways, one end of it was seen extending across the anterior chamber, and almost in contact with the lens, whilst the other extremity could be felt with a spud beneath the epithelium on the surface of the cornea. I endeavoured to seize the outer end of the chip of metal with a pair of forceps, and thus to draw it out of the eye, but this I found was impracticable; and as it seemed likely that any prolonged attempts to remove it from without, would end in pushing it completely into the eye I adopted the proceeding I have already narrated. The splinter of metal as it entered the eye, must have wounded the lens, as it was cataractous.



The patient afterwards came under the care of Mr. Bowman, and by him the opaque lens was removed. The man completely recovered, with a very excellent eye. With a + $2\frac{1}{2}$ glass he could read Jaeger's No. 1; and with + $3\frac{1}{2}$ he could tell the clock at 20 feet.

Case II.—John L., æt 62, came under my care at the Ophthalmic Hospital, on March 22, 1867, suffering from the following injury. Seven weeks previously whilst cutting down a hedge, a thorn was driven with force into the right eye. He had experienced but slight inconvenience since the accident, and had undergone no treatment for the removal of the foreign body. On examining the eye, it presented as near as possible the appearance represented in the wood-cut in Case I. The thorn had penetrated the cornea, and so deeply, that its outer end was buried below the corneal epithelium, whilst its inner half was projecting into the anterior chamber. The outer end could be felt with the spud, but knowing that it would be useless to attempt to get at it from without, I tried the plan which had answered so admirably in Case I., of introducing a broad needle through the margin of the cornea, and with the flat of the blade pushing the splinter back along the course by which it had entered. I had not however taken into consideration that although the cases were apparently similar, yet that the foreign bodies were composed of different materials. The thorn, soaked by the aqueous, had become soft and pliant, and as soon as the blade of the broad needle pressed against it, it bent towards the inner surface of the cornea. I therefore at once enlarged the opening made by the introduction of the broad needle, and passing a pair of fine iris forceps within the anterior chamber, seized hold of the inner end of the thorn, and drew it out of the eye. In doing so, however, the iris was torn by the thorn as it passed over its surface. I therefore performed a small iridectomy by excising the portion of iris which had been wounded. The lens was uninjured. The patient progressed without an untoward symptom, and on March 29th he was discharged the hospital quite well.

CASES OF RETINITIS PIGMENTOSA, WITH REMARKS.

By Jonathan Hutchinson, F.R.C.S.

Retinitis pigmentosa is so rare a disease in English practice that I am induced to record in detail the following examples of it:—

Case I.—John Brickett, æt. 57, was admitted May 9, 1867, under my care at Moorfields.

He was a thin but healthy-looking man, of dark complexion. He told us he could see well till the age of 18, when his sight gradually began to fail, especially at night. Some twenty years ago his sight failed more rapidly; but during the last five years he thought he had been much the same. During all this time, thirty-nine years, he had been without pain in his eyes, troubled with muscæ occasionally, and gradually becoming unable to see at night. This latter symptom seemed to have been well marked. He said that even when he could see pretty well in the daytime, he could not see his wife walking by his side at all after sunset, even though there was good moonlight.

There was no history of syphilis. He had had twelve children, none of whom presented any symptoms. His wife looked quite healthy. His father and mother were not related.

He could just count fingers, and direct his eyes for ophthalmoscopic examination.

The conditions in the two eyes were very similar. In each the optic disc was of a creamy grey-white; its vessels very small. It was not easy to distinguish the vein from the artery, as the latter was exceedingly small. The margins of the nerve were indistinct. The trunks of the vessels on the discs were indistinctly traced. The discs themselves, and adjacent portions of retina, were decidedly hazy. Around each disc was a large patch of grey-white, produced by partial choroidal absorption. At parts, the boundaries of this patch were definite and abrupt, at others indistinct. The choroid was everywhere pale, and speckled in most parts by dots and patches of yellow, consequent on absorption of epithelium, &c. Some of these patches

had very definite boundaries, but most of them were indistinct. In each eye, about the yellow spot, there was less disturbance of the choroid than elsewhere. At the periphery there were very extensive accumulations of coal black pigment (stars, clouds, &c.). Beneath these accumulations of pigment the choroid was seen to be yellow, and speckled with white. The pigment accumulations to the right and left of the optic disc were much more abundant than above and below.

It is to be noted that the pigment accumulations were everywhere arranged in stars, or in a sort of network. There were no absolutely isolated masses. In almost all parts wherever there was a little speck of pigment it could be distinguished that the choroid beneath it, and over a much larger area than that occupied by the pigment, had lost its epithelium. It is to be observed, however, that there were no conspicuous patches of choroidal atrophy; that is, none where the absorption of the whole thickness of the choroid was complete, and the bare sclerotic seen through.

Being much interested in the illustration of the transmission of hereditary tendencies which this curious disease supplies, I requested that one of Brickett's daughters, who, he said, was beginning to fail in sight, should attend for examination. The following are the interesting particulars of her case:—

Case II.—A daughter of J. Brickett, æt. 19, came for examination on June 6, 1867. She was of dark complexion, with brown hair, and gray eyes. She considered that she resembled her mother much more than her father. She stated that till twelvemonths before she had good eyesight, and could see to do needlework well. Her chief complaint was that "her sight left her in an evening."

With the ophthalmoscope the disc in the right eye was seen to be of good colour; at its apparent upper part was a very narrow notched crescent without pigment. The branches of the arteria centralis were rather less than usual, and not so easily traced on the surface of the disc as usual. There were, however, scarcely any deviations from the normal condition near the central parts. Towards the periphery we found the choroid

presenting numerous very small, round, ill-defined white pits, and here and there were, in connection with these, very minute dots of pigment. The chief disease was to the nasal side, and near the extreme periphery. Here we found patches of rather large size where the epithelial layer of the choroid was absorbed, and in the retina above were numerous specks and long streaks of pigment. These pigment accumulations were, many of them, placed along the course of the retinal vessels, and internal to them.

The conditions in the two eyes were quite symmetrical. The pigment accumulations were not seen in any quantity, excepting to the nasal side of the disc. On the temporal side the yellow spot appeared quite healthy, but beyond it, towards the periphery, we found numerous little white spots in the choroid, but no pigment accumulations.

Case III.—The subject of the following case is a man aged 34. His history is the following. He married at the age of 19, and considered he had very good sight for three or four years afterwards, but then he found his sight began to fail. At first he was troubled with sparks and rainbows, then he became in a fog, which was chiefly in the centre, and by looking to one side he could see better. The central fog gradually increased. Neither he nor his wife had noticed much difference in his ability to see in the daylight and in the dusk. They both say that as long as he could see his way about by day, he could at night. His sight failed slowly but steadily, and at the end of about 18 months, that is nine years ago, he was obliged to give up his work, that of iron ship building. He and his wife were not related before marriage. They have never had any children. There is no history of syphilis nor any family history of defective sight. His health has been good throughout.

The oscillations of the globes render the examination rather more difficult than usual.

The conditions are fairly symmetrical. The media are clear with the exception of a star-shaped striation in posterior pole of each lens.

The optic disc is of a gray white colour. The central vessels very much diminished, the artery is but just perceptible. The physiological cup is well marked in each. In the right eye the margin of the disc is surrounded with pigment, and the choroid

is jagged, but there is none in the left. There are no large patches of absorbed choroid anywhere, but almost universally the choroid appears to be studded with small white dots. At the periphery are numerous collections of pigment arranged in dots, streaks, &c., many of these are peculiarly fine and delicate. Amongst them the choroid is seen to be absorbed in small patches. Where the deposits of pigment are isolated each appears to be on a ground of white. The accumulations in any quantity are all situated at the periphery, the central parts appearing free, but on close examination a few dots of pigment are found near the yellow spot.

The vessels cannot be traced very far, but the pigment accumulations do not appear to coincide in direction with them.

NOTES OF MISCELLANEOUS CASES.

By Jonathan Hutchinson, F.R.C.S.

(Continued from vol. v, page 335.)

No. XIX.—*Optic Neuritis in a Child, following Severe Cerebral Symptoms.*

The following case is of interest, as an addition to the series of cases of optic neuritis in children which I reported in our last number :—

Ellen Hill, a little girl, æt. 11, apparently in good health, was brought on February 7th in a condition of total blindness. Her pupils were widely dilated and fixed, and she had the amaurotic expression in a marked degree.

On ophthalmoscopic examination we found the media quite clear, and there was no disease of the fundus, excepting in the immediate neighbourhood of the discs. In each eye the disc was swollen and "woolly," from the effusion of lymph, being of a pale grey colour, mottled with pink. The arteries were small in size, and their trunks partially concealed. The veins were of moderate size. There were no apoplexies.

The history which we obtained was that a week before Christmas she had begun to complain of headache, which was quickly followed by drooping of the right eyelid. She became very ill, and was several weeks in bed, suffering most severely from the pains in her elbows and in her head. She was early attacked by convulsions, which recurred every few hours, night and day, for nearly a fortnight. They gradually diminished in violence and frequency, and at length ceased. A week after the commencement of her illness her sight was found to be very imperfect. The failure was very rapid, and she one day exclaimed suddenly, "I can hear you, but I cannot see you."

The ptosis persisted until within a week of her admission at Moorfields. When she came to us it was about six weeks from the commencement of her illness, and, with the exception of the optic neuritis, all evidence of cerebral disease had disappeared. She was quite free from headache, cheerful, and looking well.

No. XX.—*Unsymmetrical Ocular Peculiarities in patients whose Irides were of different colours.*

I recorded some years ago some instances of unsymmetrical morbid changes in the eyes occurring in persons who had the colour of the iris in one eye different from that in the other.

The two following may perhaps be considered to have some little interest in connexion with this subject:—

Mrs. G., æt. 35, has a grey iris in her right eye, and a light-brown one in her left. Both eyes are hypermetropic one-eighth, but her right eye has also considerable amblyopia. Her left with + 8 is perfect; whilst with the right she sees only 50 (Snellen) at twenty feet, and can only read No. 4 (Jaeger). In the right eye nothing abormal is discovered with the ophthalmoscope, excepting perhaps a slight pallor of the disc. In the left eye, which is quite normal in all other respects, the hypermetropia excepted, there is a small white patch of opacity in the retina, which conceals the trunk of one of the veins. The patch is very narrow, but the venous trunk seems to pass through it. There is no similar patch in the other eye.

Mr. Frederick Mackenzie was kind enough to draw my attention to the following case. The man was under Mr. Curling's care in the London Hospital on account of an accident:—

James Hill, æt. 26, has one brown iris and one blue one. His sight appears to be perfect in both eyes, but it is curious that the diameter of the pupil in the blue eye is only about half that in the brown one.

No. XXI.—*Inherited Syphilis, with Choroiditis—Absence of ill results in the third generation.*

Mrs. E., æt. 44, came under my care at Moorfields on account of extensive opacities in her corneæ, consequent on syphilitic keratitis. She had also some opacity in her right lens, and very extensive patches of denuded sclerotic around the disc in each

eye. There were no evidences of choroiditis at other parts of the fundus. Mrs. E.'s physiognomy was characteristic of inherited syphilis. She had one typical tooth remaining, and she had been utterly deaf for eighteen years. To me the chief interest of her case consisted in the fact that she was married, and had borne a healthy family. She had three grown up children, all of whom were, according to her statement, in excellent health, and none of whom had ever suffered from disease, either of eyes or skin.

No. XXII.—*Neuralgia, followed by Glaucoma.*

The following case appears to illustrate the occurrence of glaucomatous disease of the globes in connexion with some condition of the nervous centres, of which liability to intense neuralgia is the most prominent symptom. The neuralgia of which I speak was, of course, not that which so constantly attends the glaucomatous process, but had long preceded its occurrence.

Mrs. M., æt. 50, is now quite blind in both eyes, and has a secondary cataract in each. I have had no opportunity of watching the course of the disease, and can only describe her present condition, and give the statements which she makes as to her history. She is at present in fair health; her smell, taste, and hearing are good. She is liable to what she calls seizures, during which she almost loses consciousness, but never quite. She still suffers occasionally from severe pain in the occiput, and she has recently had an attack of urticaria. In early life she was liable to very severe headaches, for which she was repeatedly bled and cupped; with the exception of these she had fair general health, and she married and bore a family. Her right eye was lost four years ago, after an attack of dreadful pain in the eye and forehead. She had been liable to most severe pain in the right forehead for some years before. After the eye had become quite blind, the neuralgia abated, but a year or two later she began to suffer in her left forehead in a similar way, and 18 months ago her left eye began to be painful as the other had been, and soon became blind. She compared the pain in the eyeballs to that of toothache, stating that it would come on very suddenly, was of a stabbing character, and would cease suddenly.

Present condition of the eyes. Neither globe is materially hardened; in both the sclerotic is thinned and bluish, and the emergent veins larger and more numerous than usual. The cornea of the right is quite clear and polished on its surface; that of the left is transparent, but is slightly steamy on the surface. The iris of the left is atrophied, deficient in lustre, and quite motionless, whilst the lens is opaque with a slight greenish tinge. In the right the lens is partially absorbed, and the iris very adherent to it; the iris tissue, however, is much less atrophied than in the other eye.

No. XXIV.—*Herpes on the Forehead.—No affection of the Eye.*

Joseph Haynes, æt. 4, was admitted on February 4, with herpes on the left forehead. There was a group of confluent vesicles in the middle of the upper lid, another amongst the hairs of the eyebrow, and others about the middle of the left forehead.

There was slight œdema of the upper lid, but there were no vesicles on the nose, nor was the lower eyelid in any way affected. The eye itself was not inflamed.

The case was a mild one, and the eruption which had come out on the day before his admission, had wholly disappeared in the course of a week. The case is of interest in consequence of the coincident absence of vesicles on the side of the nose, and of inflammation of the eye, due, probably, to the circumstance that the oculo-nasal nerve was not affected.

No. XXV.—*Herpes on the Forehead and upper parts of Nose two years ago.*

Thomas Redburn, æt. 9, applied on January 24, on account of a leucoma on his right cornea. The scars of herpes were quite distinct on the right half of his forehead, and on the right side of his nose, near to the inner canthus. There were two deep ones on the temple, near to the outer canthus, but none on the lower eyelid or cheek. The history was that the eruption had occurred two years ago, and had gone through the usual course. The ulcer on the cornea, of which the leucoma was the result, occurred two months after the eruption. There might possibly

be an error in this history, or perhaps the corneal ulcer had no connection with the herpes.

No. XXVI.—*Herpes Frontalis.—No Vesicles on Nose.—Eye not Inflamed.*

Collin Turnbull, a healthy looking lad, æt. 12, was admitted July 17, at the Skin Department, London Hospital, on account of the remains of an eruption of herpes zoster on the forehead. The remains consisted of a number of deep, well marked scars, arranged in a line just to the right of the middle of the forehead, and of two on the right upper eyelid. There were some scabs in the hair of the right side. There were none on the lower eyelid, nose, &c. The eye was not affected.

This was the fifth day of the appearance of the rash. It had not been preceded by any complaint of pain. He had been in usual health, but had had an attack of "nettlerash" on the body a few days before. The spots in the upper eyelid were said to be more recent than those on the forehead.

No. XXVII.—*Herpes Frontalis after the use of Arsenic—No vesicles on the Nose, and no inflammation of the Eye.*

Anne Robins, æt. 44, had been attending under my care at the Hospital for Diseases of the Skin since April 9th, for psoriasis. She was ordered six minims of liquor arsenicalis twice daily. On June 14th the dose was diminished to three minims three times a day. When she came, on July 12th, she presented the remains of a rash on her right forehead which she stated had appeared a fortnight before, and had been entirely confined to the right side of the forehead. At the commencement of the attack she had felt great pain all over the right forehead, and this lasted for two days, when a good many spots appeared, and the pain was considerably eased. A number of the spots had dried up at the time of her visit, and the scabs had fallen off, the spots which remained appeared to be getting rapidly well of themselves. There had been no spots whatever on the nose and the eye was not affected in the least. Scars were left where the spots had been. She complained of not feeling so well in herself when taking the medicine. The psoriasis was very much better.

No. XXVIII.—*Remarks on the importance of the exact position affected by Herpes of parts supplied by the Ophthalmic division of the 5th Nerve.*

Since my paper on this subject was published, I have had a portrait taken of G. Morgan (Case I) to show the position of the scars. His case was a very severe one, and the eye was practically lost by iritis, &c.

The wood-cut shows exactly the position of the scars. The artist has, however, found much difficulty in representing the depressions produced by the scars, and it must be considered chiefly as a key to their position.

All the cases that I have yet seen, support the opinion I have expressed, that it is only when the side of the nose is affected, that any serious inflammation of the eye ensues, and that in the worst cases the vesicles will be found on the very tip of the nose, the part supplied by the oculo-nasal nerve. In most of the cases which I have seen recently, the eruption was on the forehead only, and in none of these did the eye suffer.

NOTES OF HOSPITAL CASES.

Case I.—*Tumour of Orbit. Removal on three occasions, with return of Growth.*

(Case under the care of Mr. Wordsworth.)

(Reported by Mr. Spencer Watson.)

A married woman, 35 years of age, of spare habit, but fresh colour, was admitted into the Royal London Ophthalmic Hospital, under the care of Mr. Wordsworth, on January 25, 1865, with a tumour at the inner corner of the right eye.

The tumour was red and vascular, of the size of a filbert, and of rounded form, projects in the situation of the caruncle, smooth and moistened with mucus, and accompanied by a constant sanious oozing over the cheek. The surrounding integument of the eyelids and cheek was reddened and desquamating. She did not suffer much pain. The eyeball was very slightly, if at all, displaced, and vision was not affected. She stated that it had been growing for three years, and that it had been removed three weeks ago by Mr. McMillan, of Hull, since which, however, it had grown to the present dimension, *i. e.*, to about the same size as it was before the operation. On January 28th, chloroform was administered, and Mr. Wordsworth removed the growth, cutting deeply down along the inside of the globe, and applying the actual cautery to the raw surface. The hæmorrhage during the operation was very free, but was arrested speedily by the application of the cautery. She made a good recovery, but the growth returned within a few weeks, and, on her return to Hull, it was again removed by Mr. McMillan, who writes word to say that on March 10, 1865, "It is again sprouting out, with constant sanguineous discharge. She is more anœmic in her appearance, complains of a feeling of numbness on the right side of the head, and of dizziness. The pressure required to retard the sanguineous discharge is now irritating the eyeball, which, however, has all its motions and vision intact. I am disposed to try the caustic potash, &c., destroying as much as I can, taking care of the eyeball, the conjunctiva of which I fear is also be-

coming implicated." This patient died on 1, 1866, "in January consequence of hæmorrhage from the tumour and compression on the brain." No post-mortem inspection was allowed.

Microscopic Structure of the Growth.—When examined at its second removal, it was found to consist entirely of large soft cells, with nuclei and nucleoli very distinct, and there was an entire absence of any intercellular matrix. The cells varied in form, but not very much in size, and gave the impression of being of the soft cancerous nature.

CASE II.—*Optic Neuritis in connexion with Constitutional Syphilis.*

The following three cases are reported by Mr. Frederick Mackenzie, from the practice of Dr. Hughlings Jackson, at the London Hospital. As will be seen by a reference to pp. 261 and 262 of our last volume, Dr. Hughlings Jackson has not found reasons for believing that optic neuritis, or epilepsy," are due to syphilis in any special manner. These two symptoms will occur in association with *any sort* of coarse disease of almost any part of the encephalon.

John W., farm labourer, æt. 34.

He has been a moderately healthy man all his life, with the exception of rheumatics and jaundice, which he had while a soldier in India.

There is a history of chancre twelve years ago, also of a rash, but he had no sore throat. For this he was treated by Mr. Luke, who salivated him.

He states that he had again a chancre and a rash three years ago, while in India. Since then he has had an eruption on his feet.

For the last six months he has nearly lost his memory, not being able to remember the days of the week, and on taking a walk in the neighbourhood of his home, he could not find his way back.

For some time previous to his coming to the hospital, he had suffered severe pain in the left eyeball, and slight pain in the right, and was rarely free from pain in the forehead. He also states, that three or more years ago he had pains in both his shin-bones, in his head, and in the shaft of the humerus.

He was admitted into the London Hospital July 26, 1866, with severe pain across his forehead. He said that he could not sleep at night. He would sometimes get up in the night and walk about, staggering like a drunken man.

He was ordered a mixture containing iodide of potassium.

27th. He was in bed sleeping soundly, and was with difficulty aroused. When not in very severe pain he always sleeps soundly in the day.

Ophthalmoscopic Examination.—The media were clear. The left disc was woolly, and of a pink colour, the veins were large and embedded in the margin of the disc; the arteries were small, the disc was surrounded with recent extravasations. The right disc was ill-defined and much congested. [Extravasations were not noticed till fourteen days after this date.]

His vision was not greatly impaired, as he now and then was seen reading, without complaining of any trouble in doing so. I did not, however, test it accurately.

He left the hospital in about six weeks' time, free from pain, still taking the iodide of potassium. His memory was perfect. He did not notice that his sight failed him. Both discs were white and fluffy-looking; the retinal vessels appeared normal.

Case III.—*Optic Neuritis in connexion with Constitutional Syphilis—Hemiplegia.*

A commercial traveller, æt. 39, in the wine trade. He had been very intemperate. He is a well-nourished man, of fair complexion; he married when eighteen years old, and his wife has had six children, the last two of which were still-born. There is a history of syphilis contracted ten years ago. He then had a chancre, an abscess in the right groin, sore throat, and a rash. He was under medical treatment for these; he was salivated, and afterwards "took a good deal of sarsaparilla."

About one year ago he was seized with a fit; after which he was hemiplegic of the left side. Since he has had more than fifty fits, and has suffered a good deal from frontal headache. At first the fits only affected the left side of his body and limbs, now they affect both. They begin in the left hand.

He looks amaurotic. Says he has lost his sight for three months. The left eye began to be misty first, and he noticed that he could not see to read easily; about six weeks after this the right also became dim. His vision is very imperfect, and he reads only large print at 8″.

Ophthalmoscopic Examination.—The left disc has a woolly appearance, and is of a white colour. The vessels are diminished in size and hidden in the white material occupying the whole of the disc. The right disc is in much the same condition, except that the vessels are smaller.

He took iodide and bromide of potassium for two months, and left the hospital free from headache, and with scarcely any paralysis.

CASE IV.—*Optic Neuritis in connexion with Constitutional Syphilis.*

Eliza C., æt. 28, has been married for the last ten years; has no children, and has never had a miscarriage.

She is fairly nourished; of light complexion. There are a number of copper-coloured papules on her face. She states that she was regular until four months ago, but that her usual monthly discharge had been decreasing gradually for some time previously.

There is no history of primary syphilis, and she does not remember having had a sore throat or rash. Seven or eight years ago she "had lumps as big as marbles on both her shin bones," and suffered very severe pain in them at night. At the same time she had pain in her head also.

She has been subject to fits for a year and a half. The first happened while she was asleep. On awaking she felt the sensation of pins and needles in her left arm, and she noticed that her left arm and leg were paralysed. Since then she has had many fits—sometimes five or six a day. She knew when the fits were coming on by a tingling feeling, which commenced in the fingers of the left hand, then in the great toe, up the left leg, arm, shoulder, neck, side of face and head. She has had severe pain in the right side of head and in the right temple ever since she first had fits.

The pain prevented her resting at night. She has also noticed that she lost her memory of late, not being able to find things that she had put away a few minutes before, nor to remember her way about.

Her sight failed her soon after the fits commenced. The right eye became dim first, but they are nearly equally imperfect now. She sees nothing plainly at the distance; can make out No. 16 (J.) slowly, but it makes her eyes ache directly. Admitted into the hospital March 26th. Was ordered iodide of potassium. *Ophth. examin:* Both discs are elevated, of a white colour, with a cloudy margin. The vena centralis is large in both, and buried partially in the disc. She remained in the hospital two months, taking the medicine. The pain in her head ceased; she had no fits, but her sight was not improved.

June 10th.—I saw her to-day. She is in good health and spirits; in little or no pain; has not had any fits lately. Her sight is still very bad.

The optic discs are still slightly elevated; the margins are distinct. Both the central artery and vein are smaller than normal—the vein especially. She sees nothing in distance, and spells No. 16 (J.) slowly at 8″.

The two following cases are interesting in connexion with the preceding ones, as illustrations of some of the causes of optic neuritis. In one, the cause was a syphilitic taint, in the other the patient had been poisoned by working in mercury. The notes of both have been supplied by Mr. W. Square, one of the clinical assistants at Moorfields.

Case V.—*Optic Neuritis in connexion with Tertiary Syphilis.*

Thomas Thomas, aged 41, was admitted on May 30th, 1867. He was a very unhealthy looking man, and complained that his sight had been failing for six months. He also said that he made a great deal of water, sometimes half a gallon a day. A specimen he brought for examination gave no evidence of the presence of albumen, but contained a considerable amount of

colouring matter. The specific gravity was 1031. On questioning him as to his previous history he admitted that he had syphilis twelve years before, followed by a scaly rash, pains in his bones, nodes on his skull, and constant pain in his head. He had had four children; one was still-born, two died young, and the other was reported to be healthy.

On testing his sight it was found that he could read No. 16 Jaeger. With the ophthalmoscope the optic disc was found to be partly concealed, the edge ill-defined and jagged. The veins were large and interrupted in various places. There were no extravasations of blood. The other structures of the eye appeared normal.

Case VI.—*Optic Neuritis in connexion with Mercurial Poisoning.*

William Webb, a strong, stout man, engaged in the manufacture of calomel, was admitted on April 2nd, 1867. He stated that his sight had begun to grow dim five weeks previously, and had failed so rapidly that he was quite blind within a fortnight. He had been taken ill four months before, with pains in the limbs, and tremors, and much headache. He did not lose flesh nor appetite, but had found that he could only walk with difficulty, staggering a good deal and liable to fall, sometimes he could not stand at all.

As above stated he was quite blind, and had been so for three weeks before he came under care, though he thought occasionally he had been able to see a very bright light. The pupils were dilated and motionless, the media were clear. The optic disc appeared prominent, the vessels being pushed forwards by effusion and in some places were interrupted. The edge of the disc was ill-defined.

On April 8th, he was worse, being delirious at night, and troubled with great headache.

On May 1st, he was better, having gradually improved since preceding note, and had left the hospital. The exudation had cleared off in a somewhat diagonal direction, from within outwards, leaving behind a perfectly white surface. The veins were large, the arteries small. The margins of the disc still

remained jagged, and there had been no improvement in the state of his vision.

CASE VII.—*Symmetrical Optic Neuritis in connexion with Lead Poisoning.*

(Case under the care of MR. HUTCHINSON.)

(Reported by MR. WAREN TAY.)

Mary Welsh, æt. 19, was admitted, July 13th, 1867, at the Ophthalmic Department, London Hospital, under Mr. Hutchinson's care.

She was led into the room by a friend, being quite blind. Her pupils were large and fixed, and her aspect quite that of confirmed blindness. She told us that she had been in St. Bartholomew's Hospital until a fortnight ago, and had been in total darkness for nine or ten weeks. Her history was that she had begun to work in a lead mill two years previously, but did not find any serious inconvenience from the occupation until four months ago. She had to handle the lead, and had never taken any precautions to prevent lead poisoning. At the time mentioned, she was admitted into the London Hospital for colic, and slight paralysis of the extensors of the wrists. She recovered well and went back to her work as before, till she began to be very sick, about 14 weeks ago. The vomited matters were of a greenish colour, and the vomiting occurred very frequently in the course of the day. This went on for five weeks, accompanied by severe pain at the back of her head, and an indistinctness of vision, as if there was a film before her eyes, and then she became rather suddenly as blind as on her admission nine or ten weeks later. She also complained of a numbness in the tips of her fingers, but she could distinguish various objects given her as tests, and the difference between rough and smooth objects.

Both discs showed the usual conditions of optic neuritis, being covered with lymph. There were also numerous apoplexies near them.

CASE VIII.—*Symmetrical Optic Neuritis in a Child, without the usual history of severe Illness.*

(Case under the care of Mr. HUTCHINSON.)

(Reported by Mr. WAREN TAY.)

SINCE Case XIX, p. 43, was reported, another young patient was brought by his mother, suffering from optic neuritis.

William Wells, æt. 7, was admitted, July 22nd, at the Moorfields Hospital under Mr. Hutchinson's care. His mother said that until six months before he had been playing about with the other children, and his sight appeared to be good. About that time she began to notice that sometimes he seemed stupid, and as if he could not see objects she handed to him, occasionally missing her hand held out to him, running up against things, &c. He continued to go to school, however, as his brother led him there, till three months previously, when it became evidently useless to send him any longer. During the whole time he had not been laid up in bed; had not complained of either sickness or headache; his appetite had been good, and his mother had not thought him at all out of health.

He looked rather short for his age, quite healthy and intelligent, and seemed in good spirits. His pupils were of normal size, and acted fairly. He could spell out letters of No. 20 Jaeger, and rather better with the right than the left eye.

Ophthalmoscopic Appearances.—The optic disc in each eye was of a dirty-grey colour, and its margins were obscured by the remains of lymph. At the yellow spot there was morbid changes of the same kind as those described in the preceding cases. The central vessels were considerably diminished in size; the veins much less so, however, than the arteries.

Part II.

A Periscope

OF

CONTEMPORARY OPHTHALMIC LITERATURE.

MR. WILSON ON DISEASES OF THE EYE IN CEREBRO-SPINAL MENINGITIS.

Dublin Quarterly Journal, May, 1867.

Mr. Wilson records his experience of eye complications in connexion with the cases of cerebro-spinal meningitis which have lately been common in Ireland. Five cases are detailed, in four of which the right eye was the only one affected, whilst in the fifth both suffered. Mr. Wilson distinguishes several different elements in the disease as far as the eye is concerned. The worst is a general effusive inflammation of the globe;—cornea, iris, choroid, retina, &c., whilst in less severe cases the conjunctiva, or the conjunctiva together with the cornea may be the parts chiefly affected. Proptosis and lagophthalmos appear to be frequent, and to be due sometimes to swelling of the orbital cellular tissue, sometimes to spasm of the levator, or partial paralysis of the orbicularis. In some, the inflammation of the cornea, &c., seems to be consequent, as in cholera, &c., to exposure of the front of the eye, but in others it is not so. In the cases of panophthalmitis chemosis and hypopyon are usually present, and deep ulcers in the cornea may form. The occurrence of petechial spots is mentioned in connection with most of the cases.

Some of the eyes seem to have been saved under very unpromising conditions. Mr. Wilson strongly urges the use of atropine locally, and considering that the eye disease is a result of general blood poisoning, leaves the constitutional treatment to the physician. Mercury and iodides appear to have been used in most cases.

As regards the stage of the disease at which the eye complica-

tion occurs, it would appear to be from the third to to the seventh day.

Mr. Wilson adds that "amaurosis is not an uncommon sequence of cerebro-spinal meningitis." He attributes it to changes within the skull but says nothing as to the presence or absence of optic neuritis. It would be very interesting to have further information on this point. The subject is a very important one.

RESEARCHES INTO THE COURSE AND CONNECTIONS OF THE BLOOD-VESSELS IN THE HUMAN EYE.

By Dr. M. Leber (*Arch. f. O.*, xi, 1). ABSTRACT.

SINCE the ophthalmoscope has rendered it easy to see and examine during life the vessels of the retina, and sometimes also of the choroid, an exact knowledge of the course of the circulation in the eye has become a matter of increased interest. There are many questions that cannot be solved by ophthalmoscopic examination alone; and that require precise anatomical information. The earlier descriptions of the ocular vessels rest entirely upon injections with granular material, and the modern art of injecting transparent fluids under low pressure seems to afford a basis for further examinations. Before proceeding to state in detail the results thus obtained, it will be well to glance at the general character of the ocular circulation.

The eye and its appendages receive arterial blood almost exclusively from the ophthalmic artery; the terminal branches of which anastomose, on the eyelids, temples, &c., with those of other arteries, such as the facial, the anterior temporal, the transverse facial, and the zygomatico-orbital; so that through these also some blood may reach the outer parts of the eye. Of the vessels which supply the eyeball itself, only those of the conjunctiva anastomose with these external vessels.

The return of blood takes place chiefly through the ophthalmic vein to the cavernous sinus; and in small part also through the connection between the ophthalmic and the anterior facial veins at the inner angle of the eye.

Besides the branches to the ocular appendages, the ophthalmic artery and vein, by their ramifications, may be said to form two, or even three, distinct vascular systems: namely, the *retinal*, the *ciliary*, and, as an accessory, the *conjunctival*. These systems possess special afferent and efferent vessels, and are not completely isolated from each other, but more or less in union. The retinal system is formed from the central retinal artery and vein, which traverse the optic nerve, and send branches on all sides. The ciliary system supplies the sclera and choroid, and

is formed by the ciliary arteries and veins. Among the ciliary arteries we distinguish, 1, *the short posterior ciliary*, direct branches from the ophthalmic or the lacrymal artery, which ramify in the posterior portion of the sclera and in the choroid, and send twigs to the entrance of the optic nerve. 2. *The long posterior ciliary*, arising like the former, and supplying the ciliary bodies, the iris, and the anterior part of the choroid. 3. *The anterior ciliary*, branches from the vessels of the recti muscles, supplying the same parts as the preceding group, and also sending twigs to the anterior part of the sclera, the corneal margin, and the inner zone of conjunctiva.

The ciliary veins are, 1. *The vasa vorticosa*, which receive at the equator the greater part of the venous blood from the choroid, and twigs from the sclera. 2. *The posterior ciliary veins*, small vessels at the posterior pole, proceeding from the sclera only, and receiving nothing from the choroid. 3. *The anterior ciliary veins*, which receive twigs from the interior of the eyeball only from the ciliary muscle; and others from the anterior part of the sclera, the corneal margin, and the inner zone of conjunctiva. There are no perforating veins to correspond with the long posterior ciliary arteries.

The union between the vessels of the Retina and of the Choroid.—The retinal system is very independent, and unites with the ciliary at one point only, the entrance of the optic nerve. This union takes place chiefly through the arterial circlet described by Haller and Zinn, that is formed in the sclera immediately around the nerve entrance, and to which attention has been recently called by E. Jaeger. This circlet is formed by two or three twigs from the short posterior ciliary arteries, which enter the sclera close to the nerve, and ramify to form a fine wreath around the latter. From this wreath, as from the other short ciliary arteries, numerous twigs proceed to the choroid, and others penetrate the optic nerve. In flat preparations of the sclera, the retina and choroid being removed, and the nerve cut off level with the scleral surface, it may be seen that most of the twigs to the nerve ramify in the portion that is actually contained in the scleral foramen, either forming a delicate network around the nerve bundles, or anastomosing with branches proceeding from the central artery. In such preparations, however, some branches are divided, on their way to pass backwards, along the nerve, or inwards towards the retina. In such preparations the great vascularity of the optic nerve is very remarkable, and in perfect injections, besides the larger vessels, a fine network may be seen surrounding each single nerve bundle.

By sections parallel with the course of the optic nerve, and carried through the latter and through the sclera, choroid, and retina, a better idea is gained of the distribution of the branches of the peri-neural wreath. It is seen that the central vessels

give off considerable branches to the optic nerve, which anastomose with the arteries of the internal neurilemma, and farther forward with those from the peri-neural wreath, and form the network pervading the structure of the nerve itself: a network that is directly continuous with the capillaries of the retina. The small arteries proceeding from the peri-neural wreath proceed partly forwards to the portion of nerve in front of the lamina cribrosa, partly backwards to the trunk. These vessels as I saw them, are too fine to be visible with the ophthalmoscope; and in several injected retinæ I found that all the vessels large enough to be so visible, proceeded from the central artery or vein. It does not follow that this should be so in all cases.

The longitudinal section through the nerve shews also a direct connection between the vessels of the choroid and those of the nerve disc. This is best seen by removing the sclera and retina, and leaving only the choroid with the nerve passing through it. In such preparations very numerous arterial and venous twiglets are seen; and the chorio-capillaris is immediately continuous with the fine vascular network of the nerve bundles.

It follows that a very intimate connection exists at the nerve entrance between the ciliary system, and the vessels of the nerve itself, and of the retina; and that the ciliary vessels are subservient to the nutrition of the disc and of its surrounding parts. The connection is, however, almost entirely arterial; and only in very small part venous. After very careful search I have never found veins corresponding to the arterial wreath. The veins of the sclera around the nerve receive no branches from the choroid or from the nerve itself. They pass directly into those of the external nerve sheath; and, near the nerve entrance, the communication between the veins of the external and internal sheaths is very small, although further back it is more extensive. From the choroid alone, a few venous twigs pass directly into the nerve.

It is remarkable that this extensive vascular connection should fail to produce any reparative collateral circulation in cases of complete embolia of the central artery of the retina; so that in such cases little or no improvement of sight is usual; and in Schneller's case only,* in which the obstruction was from the first incomplete, was the patient enabled again to read fine print. The explanation probably is that the vessels are too minute to undergo the necessary enlargement in time to preserve the retina from degenerative changes; and, when these have once taken place, no establishment of a collateral circulation can be expected. The vascular network described probably plays an important part in various pathological changes, concerning which our know-

* Arch. f. O., viii, 1, page 271.

ledge is still imperfect and fragmentary; and the very fineness and abundance of the vessels shew the activity with which the nutrition of the disc requires to be maintained.

The existence of a vascular connection between the retina and the choroid at the ora serrata has been hitherto denied, since it could not be discovered by injection, and since the passage of vessels through an epithelial pigment layer was *a priori* improbable. Kugel, however, has lately described an experiment in which he applied a firm ligature tightly round the optic nerve of a living dog. The retinal vessels were at first completely blanched. An hour or two afterwards they were refilled and even distended, in a direction from the periphery towards the centre. In four days the dog was killed, and near the ora serrata were found considerable vascular loops, from which fine vessels proceeded towards the ciliary body, "and established a connection between the vessels of the retina and those of the choroid and iris." Kugel does not appear to have seen this connection, but only to have inferred it. In estimating the value of the inference it is important to remember that the same phenomena have been observed by Rosow and others in the eyes of rabbits, after complete division of the optic nerve without injury to the posterior ciliary arteries and nerves; and that in rabbits the retina is in great part without vessels, these being arranged in two lateral bundles, and in these bundles terminating in loops before they reach the ora serrata. It is hence evident that Kugel's experiment fails to afford proof of his position, since similar results were produced under conditions incompatible with the truth of his hypothesis.

Unfortunately I have no injection of the human retina in which the vessels are filled to their very finest ramifications; but I have never, after the most careful examination, been able to detect any trace of a vascular connection between the retina and the choroid at the ora serrata. The phenomena observed after ligature or section of the optic nerve may probably be explained as follows:—The current of blood through the central artery being suddenly arrested, although no more blood is conveyed towards the eye, the efflux of blood continues for a time, on account of the contraction of the vessels. This does not proceed to their complete emptying, for, when the blood pressure in the veins is less than the intraocular pressure, the further efflux is checked. As already described, the vascular network at the optic disc is mainly arterial, and through this some afflux would continue; while, the efflux being suspended, the blood would accumulate at the periphery of the retina, where the small vessels would be less influenced by intraocular pressure than larger and more central ones.

The Vascular Distribution in the Choroid.—The choroid may be divided, as regards its arterial circulation, into two portions, a posterior or true choroid, chiefly supplied by the short posterior

ciliary arteries, and an anterior, the ciliary bodies and iris, supplied by the long posterior and the anterior ciliary arteries. These divisions are connected by numerous anastomoses. The greater part of the venous blood is carried away by the vasa vorticosa, which perforate the sclera at the equator, and receive branches from the choroid, the ciliary muscle and processes, and from the iris. A small part of the venous blood, chiefly from the ciliary muscle, finds exit through the anterior ciliary veins.

Arteries of the Choroid. 1. *The Short Posterior Ciliary.*—The short posterior ciliary arteries, about twenty in number, besides many smaller ones, proceeding from the peri-neural circlet, perforate the sclera at the posterior portion of the globe. In the choroid they are at first superficial, but ramify dichotomously and penetrate more deeply, until they are lost in the chorio-capillaris. The smaller have but a small field of distribution, while the larger pass forward even as far as to the ora serrata of the retina. Brücke, in his description of the human eyeball, besides the so-called "inner" branches going to the chorio-capillaris, mentions also "external" branches passing directly into veins without capillary intervention, and "anterior" branches, running close together to the ciliary processes and iris. Hence there was supposed to be, in the choroid, a double mode of transition from arterial to venous blood—by capillaries, and directly without capillaries. Such an arrangement seemed to be *a priori* improbable; and I have ascertained, beyond doubt, that it does not exist. My injections show that all the choroidal arteries terminate in the internal layer of capillary network. The meshes of this network are finest and nearly circular near the nerve entrance, and become gradually coarser and more oblong towards the periphery. The finest arteries and veins are commonly the centres of little stars of capillary vessels; so that the network is made up of such radiating figures. On account of the greater fineness and closeness of the posterior portion of the chorio-capillaris, it is manifest that it must be in relation with a greater number of arteries and veins than the anterior portion. We find, indeed, in the immediate vicinity of the nerve a prodigious number of small vessels, among which the veins, by reason of their large diameter, are more readily discernible than the arteries. Both have a very winding and peculiar course; as may sometimes be seen with the ophthalmoscope in cases of deficiency of epithelial and stroma pigment. Even in the best preparations, it is difficult to follow the vessels in this region, unless the arteries have been filled with a different colour from the veins. The great abundance of vessels rapidly diminishes in front of the macula lutea; and, at mid-distance between the equator and the nerve entrance, all the vessels of a good preparation can be followed with facility.

The short posterior ciliary arteries do not supply the whole of

the choroid. The anterior portions, from the neighbourhood of the equator, receive branches from the vessels of the anterior division—the anterior and the long posterior ciliary arteries. These vessels pass from the ciliary muscle in a direction at first directly backwards; then ramify dichotomously in the choroid, and either terminate in the chorio-capillaris, or by anastomoses with the branches of the short arteries. Haller (1754) and Zinn (1780) have accurately figured and described these backward coursing branches; but subsequent anatomists have failed to do so. The anastomoses of these branches form the only connections between the arteries of the choroid proper and those of the ciliary body and iris. The number of the branches varies, from ten to twelve or more, in inverse proportion to their calibre; and they run backwards for a determinate distance, equal to the width of several ciliary processes. The formerly described "anterior" branches of the short posterior ciliary arteries are partly these backward coursing vessels, but chiefly veins, which carry back the blood from the iris and ciliary processes to the choroid, and which may readily be followed into the vasa vorticosa by the aid of good injecting and moderate enlargement. While, therefore, the belief, formerly entertained, that the short posterior ciliary arteries sent forward numerous branches to the ciliary processes and the iris, must be abandoned; it is found also that the anterior and long posterior arteries send branches back to the choroid. It follows that the anterior division, the ciliary body, and the iris, is much less dependent for its blood supply upon the posterior division, the choroid proper, than it was supposed to be. The anastomoses described might enable the short posterior ciliary arteries to supply blood to the anterior division under exceptional circumstances; but these vessels do not ordinarily supply even the whole of the choroid proper.

2. *The Long Posterior and the Anterior Ciliary Arteries.*—The two long posterior ciliary arteries perforate the sclera very obliquely on the horizontal meridian, somewhat in front of the short posterior. Giving off no branches, they pass forward between the choroid and sclera as far as the ciliary muscle, where they each divide into two branches, which diverge from each other at an acute angle, enter the ciliary muscle, traverse it in a course oblique to their former one, and bend into the greater vascular circle of the iris. *The anterior ciliary arteries*, branches of the arteries of the recti muscles, and, in exceptional cases, of the palpebral arteries also, perforate the tendons of the recti to reach the sclera, pass over this usually in a very winding course, to the corneal margin, where they divide into numerous branches, the most and largest of which pierce the sclera. Their external branches, given to the sclera and conjunctiva, will be described hereafter. The perforating branches reach the ciliary muscle, and, together with the branches of the long posterior, form the

greater arterial circle of the iris. This is a *complete* wreath of vessels, situated in the ciliary muscle at the boundary separating it from the iris, and in places double or triple. From this wreath arteries proceed, *forwards*, to the iris, *inwards* to the ciliary processes, *backwards* to the ciliary muscle, and some farther backwards to the proper choroid. The arteries of the ciliary processes and iris spring often from short common stems, which divide into two branches, one for each of these structures. Besides the greater circle of the iris, the branches of the long posterior and of the anterior ciliary arteries form also an *incomplete* circle, or rather series of anastomoses, lying more deeply in the ciliary muscle, and from which proceed most of the arteries of the muscle itself, and most of the backward coursing branches to the choroid.

The ciliary muscle contains a large number of small arteries, which ramify in its structure, and form a very fine and close capillary network. In the outer part of the muscle, which consists of radiating fibres, the meshes of the network are mostly parallel to the fibres; in the inner part of the muscle the meshes, as shewn by perpendicular radial sections, are irregular and polygonal.

The arteries of the ciliary processes proceed from the greater circle of the iris, and possibly also from other branches of the long posterior and anterior ciliary arteries. They pass inwards from the muscle to the processes as short branches, and subdivide rapidly into a multitude of fine twigs, which anastomose freely, and, at the free margins of the processes, pass into the commencement of veins. The arterial branches are always finer than the venous; an appearance that I at first ascribed to imperfect filling. But, having found the same appearance at the marginal loops of the cornea, it is probably normal.

The arteries of the iris form on its inner surface a loose capillary net, and an extremely fine one at the sphincter pupillæ. Some branches form, at a definite distance from the pupillary margin, the smaller arterial circle of the iris. It is remarkable that the iris is very difficult to inject in adults, while the choroid may be injected easily. The reason may be that the arteries of the iris, which possess very thick walls, are strongly contracted after death by their elasticity, and oppose considerable resistance to the entrance of the fluid. In the eyes of children good injections of the iris are easy. At the margin of the pupil the finest arterial branches pass into the venous.

II. Veins of the Choroid.—1. *The Vasa Vorticosa.*—These large veins, of which there are usually five or six larger, and a variable number, from one to six, smaller, receive most of the blood from all parts of the choroid. Before their exit from the eye, the smaller trunks usually unite with the larger, so that more than six seldom pierce the sclera. They do so in the

equatorial region; and, like the long posterior ciliary arteries, in a very oblique direction, so as to form in the scleral tissue a canal several millimetres in length, with which the walls of the vein are closely united. It is not impossible that this arrangement may, under certain circumstances, maintain and increase a heightened tension of the eyeball, however arising. Since the sclera at the site of the venous canal is reduced to its minimum of thickness, and can scarcely possess enough strength to protect the inclosed vein against an increase of pressure, it may follow that such increase would close the vein like a valve, and thus, by the retarded efflux of blood, produce in its turn a greater pressure. Upon the long ciliary arteries there would be less of this influence; and the tension must be very considerable before it would begin to affect them. Whether such occurrences actually take place or not, can only be determined by direct experiment.

All the choroidal veins leave the eyeball in the region of the equator. The small posterior ciliary veins, which are found at the back part of the globe, receive blood only from the sclera. There are no veins in the choroid that correspond in their course to the long ciliary arteries; although the existence of such has been generally assumed, and they have even been figured. The veins in the choroid form the well known *vortices*, in which the central trunk receives vessels from all sides, and in which the branches of neighbouring vortices inosculate. Between two vortices a vein usually passes from before backwards, not opening direcely into either, but into the first branch of communication between them. This seems to be the foundation of Arnold's figure in his Icones, representing a vein passing forward to the ciliary muscle, and having no special exit from the sclera. Zinn, on the contrary, makes his long ciliary veins commence in the ciliary muscle, receive twigs from the iris, and accompany the long ciliary arteries. For this I can find no foundation, excepting that two veins from the ciliary muscle sometimes accompany the branches of the long ciliary artery for a short distance, and then unite in a common trunk, which always, however, at the posterior margin of the ciliary muscle, opens into one of the branches of a vortex.

The venous branches coming to the vortices from behind allow the short ciliary arteries to lie for a space between and parallel to them; and in the most posterior portion of the choroid it is scarcely possible to distinguish the two kinds of vessels from each other. Their intimate and close connection may serve in some degree to regulate the flow of blood. If, for example, a somewhat large quantity was driven into the arteries, the veins would experience a stronger pressure, in a direction from behind forwards, by which the outflow of venous blood must be promoted. Inversely, if from venous obstruction the arteries were

compressed in a direction from before backwards, an obstacle to the afflux of blood would be produced. In this way it is possible that small inequalities of the blood current may be neutralized, and that considerable oscillations in the blood contents of the eyeball may be prevented. The veins which come to the vortices from before receive blood from the iris, the ciliary muscle and processes, and the anterior portion of the choroid.

The veins of the iris, as far as I could observe, all pass backwards between the ciliary processes, to the numerous veins in the smooth part of the latter; which also receive the veins of the processes themselves, and some of those of the ciliary muscle. I never saw veins pass directly outwards from the iris to Schlemm's canal; nor from the canal outwards through the ciliary muscle; but I have seen veins pass outwards from the vascular net of the muscle itself. But the vessels of the iris, of the ciliary muscle, and of the processes are so often and so intimately connected, that blood may perhaps pass forwards from the iris through the muscle. The vascular net of the iris passes directly into that of the processes.

The veins of the ciliary processes arise from their vascular network, and a larger vein usually emerges from the free margins of the processes. In the interspaces of the processes lie the veins coming from the iris, and form with those of the processes a venous network, that lies immediately beneath the internal surface, and the trunks from which pass through the smooth part of the processes to the choroid, first to its anterior margin, and then onwards to its external surface. The veins of the ciliary processes and iris are therefore wholly within the ciliary muscle, do not pass through it, and are quite withdrawn from its action; while all arteries to these parts pass through the muscle, and, from the direction of its fibres, must be compressed by its contraction. We should therefore expect that in accommodation for the near point the blood contained in the ciliary muscle would diminish; the afflux being checked and the efflux unimpeded. It is well known that the contrary has usually been assumed, namely, that the contraction of the ciliary muscle would produce a blood stasis in the processes. This, however, the arrangement of the vessels seems to render impossible. Very lately O. Becker has observed, in the eyes of several albinoes, that the ciliary processes, the summits of which could be seen through the iris, were shorter in near accommodation, and more prominent under the influence of atropine. Becker explained these appearances chiefly by the coincident changes in the diameter of the pupil. In dilated pupil the iris would not be capable of receiving so much blood as when the pupil was small. On account of the intimate vascular union between the iris and processes, a part of the blood of the former, expelled during the action of atropine, would be driven into the latter; and the contrary result would follow when the

pupil contracted in accommodation. That such a correlation may exist between the iris and the processes seems probable; but the exact action of the ciliary muscle upon the vessels passing through it is a matter that requires further examination. I am content for the present to point out an arrangement that appears to me not to be unimportant.

The veins of the ciliary muscle proceed partly from the posterior margin and inner surface of the muscle as small trunks going to the veins of the processes, and, when united with these, passing into the vortices. As already mentioned, some of the veins sometimes accompany for a space the circular branches of the long ciliary artery, but still empty themselves into a vortex. Besides these, another portion leave the anterior margin of the muscle, and pass through the sclera to the anterior ciliary veins.

2. *The Anterior Ciliary Veins.*—The existence of an anterior channel of exit for venous blood from the choroid has been assumed by most anatomists and ophthalmic surgeons. The latter, indeed, supported by clinical observation, maintained that distension of the veins passing over the sclera was very often observed in hyperæmia or inflammation of the choroid. There was a want of unanimity only with regard to the mode of exit of the veins, and upon the question whether they passed out from the iris, as well as from the ciliary muscle, and whether their exit was direct, or that the veins emptied themselves into Schlemm's canal, and from this branches passed outwards. Rouget, on the contrary, entirely denied the existence of any anterior channel of exit for the venous blood of the choroid. He declared that all the choroidal veins emptied themselves by the vortices; and that Schlemm's canal, both in man and in animals, was only a circular venous plexus in the sclera, perfectly unconnected with the vessels of the choroid.

My own researches have been upon human eyes only; and they confirm those of Rouget on one point, that the so-called Schlemm's canal is really a venous plexus, but not on another, that it has no connection with the vessels of the choroid. I have found the plexus to be differently constituted in different parts of its circle, consisting for a short distance of six or seven veins of about equal size, formed into a network by connecting branches, then of two large and several small veins, sometimes of one large and several small. In the latter case the large vessel has a calibre of about 0·225 mm. There is therefore no circular canal, but only a circular plexus of veins in the innermost layer of the sclera, immediately external to the insertion of the ciliary muscle. This plexus would be most simply named Plexus ciliaris venosus. At several points it receives small veins, which issue from the ciliary muscle near its anterior margin. These are often accompanied, at their issue from the muscle, by a small perforating artery, pursue for a short distance a very tortuous course upon

the sclera, and receive from its innermost layer small veins, which have there formed a loose irregular network of very fine vessels. They then, at a short distance from the ciliary plexus, divide into several twigs, which freely inosculate, some of them opening into the plexus, others passing outwards through the sclera, to communicate with its superficial venous net. Since, immediately before opening into the plexus, they divide into several branches, they practically form, at their places of entrance, looser continuations of the plexus in a backward direction; and from these arise the venous branches that pass outwards. In a single eye I counted from 18 to 20 of such entrance places. The compact part of the plexus receives no vessels, either by its outer or inner surface; they are received only at the posterior margin in the manner above described. The veins from the outer parts do not therefore directly enter the plexus formerly known as Schlemm's canal; but they enter its prolongations backwards at the places of entrance of the veins of the ciliary muscle. The blood from the ciliary muscle may therefore partly flow in a direction directly outwards; partly into the ciliary plexus which serves as a reservoir. At every entrance place of a vein from the ciliary muscle, several veins pass outwards through the sclera, some of them sometimes of considerable calibre, and at these places the deep plexus becomes practically continuous, through the sclera, with the episcleral network of the anterior ciliary veins. We see also in sections that the sclera is far richer in vessels at its most anterior portion than elsewhere, where large vessels are found only upon its surface; and this anterior vascularity is due to the veins of the ciliary plexus that pass outwards. They pass through the sclera mostly backwards and outwards; but sometimes vessels are seen going obliquely forwards to meet the veins of the margin of the cornea, and to establish a direct union between these and the deep plexus.

The existence of an outlet for the venous blood of the choroid through the anterior ciliary veins is thus rendered certain, and the differences in the descriptions given by previous observers may be explained by supposing that they had traced out only parts of the actual arrangement. The anterior efflux of blood differs, however, from the afflux through the anterior ciliary arteries, in its much smaller amount. Only a small portion of the blood brought by the anterior ciliary arteries is carried back by the anterior ciliary veins, and the united trunks of the latter are smaller than those of the former. The greater part of the blood brought by the anterior ciliary arteries is carried away through the vortices. This, however, does not prevent the anterior outlet from coming into prominence in pathological conditions, in which the outlet through the vortices is from any cause impeded. Thus we find the anterior ciliary veins dilated in hyperæmia and inflammation of the choroid, when these are not

very chronic; but it may be doubted whether this dilatation is a result of increased collateral outflow, or of inflammatory irritation. The former is the most ready explanation of the great distension of the anterior ciliary veins in chronic and complete glaucoma; since, as I have already observed, the strong intra-ocular pressure may impede the outflow through the vortex veins, and force the blood to seek the anterior channels.

The combination of the ciliary plexus with this anterior outlet forms a very remarkable and important provision. The plexus serves as a reservoir, placed at the anterior extremity of the muscle, and into which venous blood may flow, when squeezed out of the muscle by its contraction, and from which it may return when the contraction ceases. The great vascularity of the muscle seems to render such a provision highly intelligible; although, as long as there is no unity of opinion with regard to the function of the muscle itself, it is very difficult to speak certainly upon the point. It seems to me certain, as a matter of anatomical position, that the action of the ciliary muscle must exert an influence upon the vessels of the plexus.

The External Blood-vessels of the Eye.—In so far as the eye-ball is covered by conjunctiva, we must recognize two external layers of vessels—a superficial, the vessels of the conjunctiva and of the sub-conjunctival tissue; and a deep, the extension of the anterior ciliary vessels upon the sclera.

The vessels of the peripheral part of the scleral conjunctiva proceed from the vessels of the eyelids. They are in their ramifications almost wholly distinct from the subjacent anterior ciliary vessels, and only isolated branches of the latter pass into the conjunctiva. In the annulus conjunctivæ, on the contrary, a great number of small arterial and venous loops pass into the conjunctiva and ramify backwards, in order to supply the innermost zone of the conjunctiva, and to anastomose with the peripheral vessels.

I. The Anterior Ciliary Vessels.—1. *The Anterior Ciliary Arteries.*—As already mentioned, the anterior ciliary arteries proceed from the arteries of the recti muscles, and perforate the tendons to reach the sclera. Commonly two branches are given on the upper, inner, and lower sides; and only one on the outer, that one being usually small. They pursue a winding course towards the margin of the cornea, and at some distance from it divide into several branches, which, after giving off fine episcleral twigs, perforate the sclera vertically. Two adjacent arteries often unite to form a loop, from which perforating branches are given off. Besides these muscular arteries, an anterior ciliary branch is occasionally given off by a palpebral artery, and traverses the conjunctiva nearly to the margin of the cornea, where it sinks to perforate the sclera. Zinn described such a vessel, and so also has van Woerden, but I have not

seen it myself in any injected eye. Van Woerden describes it as being readily recognizable in the living subject, almost always on the outer side, mostly a little towards the lower part, as a straight, bright red vessel, giving off no branches, traversing the conjunctiva nearly to the corneal margin, and there piercing the sclera. It should be found in about one out of four persons. I examined more than a dozen, however, before I found a vessel to correspond to the description.

The trunks of the anterior ciliary arteries are very clearly visible in healthy eyes, and are usually the most conspicuous vessels. They may sometimes be seen to issue from the tendon; and may be followed along their whole course to their place of perforation. Their colour is more carmine than bright red, being somewhat veiled by the conjunctiva covering them. They are thus readily distinguishable from the superficial cinnabar red vessels of the conjunctiva; and, moreover, the conjunctiva is movable over them, while they are themselves only somewhat movable with the subconjunctival tissue, in the most external portion of their visible course. That they are arteries may be shown by the speed with which they refill, and by the direction of the incoming current, when they have been emptied by pressure through the eyelid. They are also distinguished from the ciliary veins by their winding course and their very visible perforating branches. The places of perforation of the latter are commonly rich in stellate pigment cells, which give the appearance of a dark border around the vessel.

With the naked eye we see no other branches of the anterior ciliary arteries than the perforating ones, but we see also, as van Woerden rightly observes, that they become continually finer towards the corneal margin. Only here and there a small twig may be seen to leave them, and to lose itself on the scleral surface. There are, however, numerous episcleral branches, which, at the peripheral parts of the sclera, are concealed by the thickness and opacity of the conjunctiva, and which, nearer the corneal margin, are too fine to be clearly visible, even when the conjunctiva is thin. The episcleral branches form upon the sclera a rather open network, from which the likewise open network of the scleral capillaries proceeds. The fine arterial twigs may be distinguished from veins by their more winding course. The branches that extend farthest backwards anastomose with the anterior scleral branches of the posterior ciliary arteries.

At the margin of the cornea the episcleral vascular system undergoes a greater development. The episcleral branches of the anterior ciliary arteries here bend laterally, and unite to follow, in the annulus conjunctivæ, a course nearly parallel to the corneal margin. They form together anastomosing loops, from the anterior aspect of which fine vessels are given off at regular distances, to form the marginal vascular network of the cornea,

and to supply a number of twigs to the conjunctiva. Sometimes the anastomosing branches in the annulus are large enough to be seen in the living eye, but this is not the rule. By following them with the microscope it is found that, besides the larger, a number of small twigs become visible.

Before proceeding to describe farther the course of the vessels, I must make some observations upon the margin of the cornea. The so-called annulus conjunctivæ, that is, the marginal part of the conjunctiva still possessing submucous tissue, extends a certain distance over the margin of the cornea, and extends further above and below than on either side. The cornea, viewed from the front, appears therefore as a recumbent ellipse, while its posterior boundary, the edge of the ciliary plexus, is always circular. The tunica propria of the scleral conjunctiva passes over into Bowman's membrane, not abruptly, but through a narrow zone in which the conjunctiva is no longer movable, and therefore has no subconjunctival tissue, but still is not homogeneous, and appears fibrillated. In this zone it is scarcely possible to distinguish, in microscopic sections, the conjunctiva from the subjacent cornea. On the surface Bowman's membrane appears to extend somewhat outwards, while the deeper parts are still fibrillated. The fine vascular network extends about as far over the cornea as this marginal zone extends, and then terminates in capillary loops. It is difficult to say that these vessels are in the conjunctiva, since this can hardly be distinguished from the cornea, but it can be said that they are in the most superficial layer.

The before-mentioned fine arteries, that pass over on to the corneal margin at equal distances from one another, and that I call the arterial mother-vessels of the network of marginal loops, are continued in the limbus conjunctivæ and in the marginal zone of the cornea by repeated dichotomous division, so as to form a network of very fine meshes, with acute-angled interstices. The arteries are here distinguishable by their unusual fineness, and have an unusually rectilinear course. The mother vessels of a well injected preparation may be seen by the naked eye, but their fine divisions cannot be distinguished without a lens. The fine divisions of the arteries are usually accompanied by veins running a similar course, and they repeat, on a small scale, the plan of formation from which they spring, forming loops, and giving off finer vessels from them. The smallest arteries form winding curves, and, gradually dilating, pass into veins. There are generally several rows of loops one before another, the most external forming the peculiar marginal loops in the clearest manner. The recurrent venous limb of the loop is always considerably thicker—in my injections at least twice as thick—as the arterial limb. It has already been said that this vascular network extends about as far inwards as the fibril-

lation of the conjunctiva; and farther inwards, upon the true cornea, no vessels are found.

It would lead me too far if I were to enter into the arguments for and against the existence of the so-called serous vessels of the cornea, and I will only give the results of my own observations. I could never, in the most successful injections of normal eyes, even those of children, in which the marginal loops could be fully distended, discover any vessels in the cornea; and, moreover, the marginal vessels are themselves so fine that they would only suffice for the supply of their own loops, and not for vessels extending farther inwards. In apparently normal eyes I found vessels extending as far as the middle of the cornea, but in these cases always obtained proof, by fine sections, of the existence of pathological changes, by which such vessels had been newly formed; so that they were not parts of the normal corneal structure.

It has hitherto commonly been assumed that the vascular loops of the corneal margin were formed from the conjunctival vessels, while they are, in fact, given off from the ciliary arteries. Indeed the reverse of the first proposition is more true—that the conjunctiva immediately around the cornea receives its vessels from the ciliary system. Numerous vessels pass from the mother-arteries of the marginal loops into the conjunctiva, at a distance of from one-third to one-half a millimetre apart, pursue a backward course, ramify and subdivide in an inner zone of conjunctiva three or four millimetres in breadth, and anastomose with the peripheral conjunctival arteries. These vessels correspond with the *anterior conjunctival vessels* of van Woerden, and I will call them anterior conjunctival arteries. They are mostly very fine, so that in the normal eye they cannot be seen until magnified. They then become visible at the inner margin of the annulus conjunctivæ, ascending from the deeper parts, and having usually a course of three or four millimetres. Farther away from the cornea they become larger, and farther away still only single vessels ascend, of which the larger may be recognized with a lens in a healthy living eye, since they are nearly always accompanied by veins of similar course and larger size, which may themselves often be seen by the naked eye. These are obviously the anterior conjunctival of van Woerden, who, on account of their fineness, overlooked the corresponding arteries.

2. *The anterior ciliary veins*, like the arteries, are branches of the vessels of the recti muscles. Their trunks correspond with the arteries in their course, not exactly, but generally. There are sometimes more, as two or three, for each muscle; while there are never more than two arteries. The episcleral branches commonly accompany the corresponding arteries, one on each side. Since the anterior ciliary veins only bring back a portion of the blood that the anterior ciliary arteries convey, it follows

that the veins are much smaller than the arteries. These veins are the *episcleral vessels* of van Woerden, about which he certainly assumed that they were mostly veins, but yet suspected that some were arteries. During life they are not visible in all persons, but chiefly in those with a thin conjunctiva and somewhat hyperæmic eyes. In irritation of the eyes they become very conspicuous and much dilated, even only from rubbing the eyes with their own lids, and much more when any foreign body is present in the conjunctival sac, or impacted in the cornea. In these vessels the same branches can be distinguished as in the arteries, namely: 1. branches from the capillary network of the sclera; 2. to the marginal network of the cornea; 3. anterior conjunctival veins; 4. perforating branches.

The trunks of the anterior ciliary veins divide near their origin into several branches, which ramify in an arborescent manner over the sclera, and which form loops near the cornea after the manner of the arteries, but somewhat farther from the corneal margin. These loops, like the arterial loops, send forth twigs, running over the margin; the venous mother vessels of the network of marginal loops. The veins have, during life, the same carmine-tint as the arteries, and are chiefly to be distinguished from the latter by their greater diameter and their less winding course. All the branches of the anterior ciliary veins lie immediately upon the sclera, and are connected together by a network of fine polygonal meshes, which become gradually larger the more distant they are from the cornea. The arteries form, in the same part of the sclera, the already-described far looser network, in which they are commonly accompanied by two veins. The episcleral venous network is, therefore, not a capillary net, but a net of venous anastomoses, like the ciliary plexus, with which it is in intimate connection. In normal eyes it is not visible, but in irritated eyes it becomes apparent, although not so much so as the larger branches of the anterior ciliary vessels. It is seen very well in cases of iritis and of other deep ophthalmiæ, producing the well-known deep-seated zone of bluish-redness that surrounds the cornea, and that can never be completely resolved into individual vessels. The venous mother-vessels of the network of marginal loops pass over the corneal margin, and are connected together by a continuation of the episcleral venous net, with still finer meshes. The finer twigs are accompanied by still finer arteries, and form loops, from which proceed the finest twigs that pass over into arteries in the manner already described.

The anterior conjunctival veins are formed, like the arteries, by loop-shaped branchings of the venous twigs in the annulus conjunctivæ; and, as van Woerden correctly states, may be clearly seen in the living eye, where a superficial bright-red vessel may be seen to change by a winding course into deep carmine. Soon

after their origin they approach, and afterwards accompany, a conjunctival artery. They form the greater part of van Woerden's anterior conjunctival vessels; since the arteries are mostly too fine to be seen by the naked eye. Of the veins themselves only the largest are visible in normal eyes; and hence van Woerden greatly understated their numbers. Vessels exceeding a certain degree of fineness are no longer visible; probably for the reason given by Liebreich, to explain why the chorio-capillaris of the human eye cannot be seen with the opthalmoscope; namely, that the small quantity of blood contained in them does not carry sufficient colouring matter to define them sharply from their surroundings. The anterior conjunctival veins correspond entirely in origin, number, and course, with the arteries; and, like them, form connections with the posterior conjunctival vessels, into which they sometimes seem to empty themselves. Often such inosculations are so large as to give an appearance as if the posterior conjunctival vein formed the outlet for the blood from the marginal loops, or even from the interior of the eye. Such an appearance corresponds with the presence of an anterior ciliary artery coursing through the conjunctiva, and is only exceptional. As a rule, the anterior conjunctival veins discharge their blood into the ciliary veins. The branches between the anterior ciliary veins and the ciliary plexus and muscle, have already been accurately described. Some of the outcoming veins from the latter are sometimes very considerable; so that they appear on the sclera as large veins coming from the deeper parts. Van Woerden points out that during life such branches are mostly seen near the corneal margin, having a dark colour, and appearing to come from the interior of the eye. He also points out the connection between such branches and the fine vascular wreath around the cornea.

Of these deep branches also, although they are regularly present around the whole circumference of the eye, only a part are visible; the rest not being thick enough to be seen through the conjunctiva. In a case of chronic cyclitis I saw these deep branches of the anterior ciliary vein very clearly and in numbers; while the injection of the mother-vessels of the margin was less pronounced. Van Woerden states that in cyclitis the injection of the corneal margin is wider and stronger, and appears more deeply situated than in iritis, a result that may depend upon the branches of the anterior ciliary veins that pass through the sclera being more distended.

II. The Posterior or proper Conjunctival Vessels.—The peripheral parts of the scleral conjunctiva, and of the sub-conjunctival tissue, obtain their blood from the palpebral and lacrymal vessels. These may be seen at the reflection of the conjunctiva, or in the scleral portion, as small, bright red, slightly winding trunks, that can be moved with the conjunctiva, and that pass

forwards. They form by their branches little loops, from the convexities of which other and finer vessels arise. As with the anterior vessels, each fine artery is usually attended by a somewhat thicker vein; and often there is a vein on both sides of the artery. Both arteries and veins anastomose with the anterior system, at about four millimetres from the cornea, in the manner already described. These vessels can usually be clearly seen in the normal eye, although the arteries require careful looking for. These are the vessels that become injected in catarrhal ophthalmia. They form a capillary network, lax in the proper scleral conjunctiva, but much more dense at the reflection. It is not possible, as van Woerden also observes, that simple hyperæmia of these vessels should make the eye *deep red.*

Of the external vessels of the eye, we therefore see in the living only a portion; namely, first, the anterior ciliary arteries with their larger perforating and with indications of their episcleral branches; the anterior ciliary veins only occasionally, but always when the eye is irritated, in which case their trunks and larger branches, their branches to the network of marginal loops, their larger perforating branches, and a portion of the episcleral venous network, all become recognizable, as well as the posterior and the larger of the anterior conjunctival veins, and sometimes the accompanying arteries. All conjunctival vessels, whether arteries or veins, are distinguished by their bright cinnabar-red colour, although the network of corneal marginal loops, which in irritated or inflamed eyes are sometimes much filled, is also bright red. Between the arteries and veins of the conjunctiva no difference of colour can be perceived. All sub-conjunctival vessels, however, are carmine-red, be they arteries or veins. The difference of colour depends chiefly upon the deep vessels being covered by conjunctiva, and, perhaps, partly, as van Woerden suggests, upon the action of the atmosphere upon the blood in the more superficial.

In pathological conditions, portions of the external vascular system of the eyes are often more distended, so that vessels naturally invisible are brought into view. Such vascular injection, when it does not depend upon the formation of new vessels, is chiefly venous. The arteries are so fine, and their development, as it appears, so much less considerable, that they contribute comparatively little to the apparent hyperæmia. Further observations are required to determine whether the arteries, in many cases, are actually dilated or not.

In inflammations of the eye, therefore, there are chiefly three kinds of vessels distended. 1. *The posterior conjunctival*, which are injected in catarrhal disorders, and of which the veins are chiefly influenced. 2. *The anterior ciliary veins and the episcleral venous net.* The injection of these vessels may be either partial or more general, and the branches proceeding from the network of mar-

ginal loops may also be distended, as well as the deeper ones coming through the sclera. This kind of injection is seen in phlyctenulæ, and in affections of the cornea and of the inner ocular membranes, when these are not entirely chronic. The episcleral venous network becomes especially filled in acute iritis and in cyclitis. Since the anterior ciliary veins course over the surface of the sclera, the conjunctiva can be moved to and fro over them. 3. *The anterior conjunctival vessels and the marginal loops of the cornea.* Injection of these vessels is almost always accompanied by injection of the anterior ciliary veins, although the latter may be injected without the anterior conjunctival vessels participating. The aspect of the injection at the corneal margin in such cases is therefore mixed, and is produced on the one hand by the greater fulness of the episcleral venous net, which shows through the conjunctiva; and, secondly, by the injection of the thence arising anterior conjunctival veins, and even of their arteries. In such cases we also see, by microscopic examination, the marginal loops very strongly injected, although it is seldom possible to make out the arterial branches of the network, that are seen extremely well in preparations. The unsteadiness of the patient, and the ready lacrymation of the irritated eye, are the chief impediments; but by continued examination and practice, more and more of the vessels may be brought into view. This third form of injection is best seen in cases of slight central corneal infiltration, and of foreign bodies in the cornea. The more strongly injected network of marginal loops appears as a very fine red zone, surrounding the cornea, from which proceeds outwards a very fine radiating striation (the anterior conjunctival vessels). This is seated in the conjunctiva, but is not very movable, on account of the adhesion of the conjunctiva at this point to the subjacent tissues. Still further outwards are the larger anterior conjunctival veins, springing from the episcleral network.

Different appearances of the ciliary injection at the margin of the cornea may depend upon the conjunctiva of the limbus being more or less swollen. Serous infiltration in this region may almost entirely conceal the episcleral veins or even the beginning of the loops, so that only the superficial injection of the conjunctiva shall be visible. With abatement of such swelling the state of the vessels becomes more apparent.

In phlyctenulæ of the margin of the cornea we always see several posterior conjunctival vessels continued to the margin, and there dividing into branches. The anastomoses between the anterior and posterior vessels are therefore dilated, and a kind of bridge is made between the conjunctival and the ciliary vascular systems.

The cornea, as I have already stated, possesses no vessels in its normal condition; but in pathological states we often see in it new vascular formations, proceeding from the vessels of the mar-

gin. Under certain circumstances such new formations occur with great rapidity, so as to lead to the belief that they are dilatations of pre-existing serous vessels. In other morbid processes in the cornea no vessels are formed during a long period; especially when such processes have a destructive character. The appearance of vessels is then an indication of improvement. It seems as if the formation of vessels depended chiefly upon the greater or less degree of nervous irritation accompanying the pathological process concerned. Thus in slight turbidity of the cornea with active vascular formation we see symptoms of much irritation, ciliary neurosis, photophobia, and lacrymation; while in the so-called passive purulent infiltrations of the cornea there are neither symptoms of irritation nor formation of vessels. It seems therefore that the degree and extent of the corneal structural change has less influence on the formation of vessels than the nervous irritation set up by the primary disease.

Since the entire circumference of the cornea receives twigs from the ciliary vessels, those that are prolonged over the cornea can only arise from the same source. The only differences between different corneal vascular formations will be, therefore, that they may arise from different branches of the ciliary system. Thus the branches of the network of marginal loops may be prolonged over the surface of the cornea; or the larger vessels of the annulus; while deeper vessels in the cornea may be prolongations of the deep scleral vessels, or of the veins of the ciliary plexus.

It appears also, that the form of the new vessels in the cornea is the expression chiefly of the nature and course of the pathological processes underlying their development; and depends upon these, rather than upon the branches from which they spring. Thus, among the superficial vascular formations, we distinguish pannus from the tuft-shaped varieties of keratitis. In pannus there are superficial, slightly winding vessels, that spread in an arborescent manner, among very turbid tissue. In the tuft-shaped keratitis, on the contrary, closely packed straight vessels, ending sharply in loops, and with the infiltration commencing where they terminate. In a case of trachomatous pannus, that I carefully examined, the mother vessels of the marginal loops were prolonged for some distance into the cornea, and between them were others less prolonged. There was thus a loose continuation of the network of marginal loops inwards, in many places not easy to discover. Besides these fine vessels ran a very marked one from above to beyond the centre of the cornea, slightly winding and arborescent. This was a vein, and near it was a very fine artery. The vein sprang from the annulus conjunctivæ, from a branch of the anterior ciliary veins, which also, at the same spot, received from the other side a large anterior conjunctival vein. Two small vessels of similar

course extended into the cornea from below. In phlyctenular vascular bandlets again, the vessels pass on to the cornea only from the mother vessels of the net-work of marginal loops, and as far as the origin of vessels is concerned, pannus would be distinguished from phlyctenulæ chiefly because in the former still larger vessels would be continued into the cornea from the larger branches of the anterior ciliary vessels in the annulus conjunctivæ. In fact, however, the actual distinction is that in the tuft-shaped keratitis the vessels grow quickly and are behind a circumscribed infiltration, while in pannus the inflamed surface is more extensive, and the irritation not so acute, but more lasting.

With regard to vascular formations in the deeper parts of the cornea, they may occur in all layers. I have observed one case in which winding continuations of the veins of the ciliary plexus passed into the deepest corneal layers. Since very fine arteries are found in the marginal portion of the sclera, even in its deepest layers, it is possible that these arteries may throw continuations into the cornea. As a concluding observation I would remark that a formation of new vessels is often seen in the conjunctiva, the sub-conjunctival tissue, and on the surface of the sclera as results of inflamation. The capillary network of the sclera has meshes so wide, that even a very considerable increase of its vessels would produce no great redness of its surface. In the not uncommon cases, in which the conjunctiva is so much injected as to resemble a red cloth, a formation of new vessels must be assumed; and I possess injections from such cases, in which the conjunctiva is pervaded by an abundant net-work of very wide capillaries. In much slighter degrees of injection the formation of new vessels has appeared to me to play an important part. In some injections of diseased eyes I have been able to reproduce almost the exact picture of the condition during life; and on closer examination of such cases I not only found the vessels dilated, but also much more numerous than in the most complete injections of healthy eyes. I must return to this subject in future, when I have examined pathological vascular formations with more exactness.

UPON THE INFLUENCE OF INTRAOCULAR PRESSURE UPON THE CIRCULATION IN THE EYE.

By Dr. Mitrophan Memorsky (*Arch. f. O.*, xi, 2, p. 84). ABSTRACT.

THE author commences by mentioning that the course of the blood is governed by special laws in certain organs, as in the liver, the spleen, and the brain. Until the invention of the ophthalmoscope it was not known that the eye must be included among them. The pulsation of the central vein of the retina is sufficient to show the necessity. This characteristic peculiarity

has attracted the attention of many inquirers during the last decennium, and especially of Donders.

A second peculiarity of the intra-ocular circulation arises from the division of the blood-vessels in the eye. Tirsch, Brücke, and Schroeder van der Kolk had pointed out the existence of two independent vascular systems, the ciliary and the retinal. Donders has sought to explain the physiological relations of the two systems by the hypothesis that they serve to regulate each other. It cannot be said that the hæmostatics of the eye were by this sufficiently explained; and it is, for example, wholly unknown what is the influence of disturbances of the general circulation upon the circulation within the eye, or of disturbances of the circulation in neighbouring organs, or in the vessels between the eye and the heart.

It must be admitted that the disturbances of the ocular circulation have not been treated with sufficient clearness by writers; hyperæmia of the choroid, for example, having been assumed to exist on the ground of analogy, and in the belief that hyperæmia is possible wherever there are blood vessels. We shall see that this rule is not without exceptions.

After briefly alluding to the experiments of Kussmaul and Schneller, the author proceeds to describe his own. The animals employed were, excepting the rabbits, narcotized by the injection of opium into their veins, and at the same time the pupils were kept dilated by atropine. The vessels, arterial or venous, that were experimented with, were laid bare, and surrounded by loops of twine, that were not knotted, but tightened by an assistant at any time. The fundus of the eye was observed through a three inch lens. An ophthalmoscopic micrometer was not employed, on account of the insuperable optical and mechanical difficulties—difficulties by which, as the author clearly shows, the very precise statements of Schneller are deprived of all value.

Kussmaul simply compressed with the finger the carotid artery of a rabbit, and found that the *fundus oculi* on the side compressed became somewhat paler. He then tied first one carotid, then both, and lastly the innominate artery; and found in all these cases a regular pallor of the fundus, corresponding with the anæmia of the brain. The author repeated this experiment both on dogs and rabbits, and found:—

In permanent or intermittent interruption of the flow of blood by ligature of the carotid, an interruption of the current of the *central artery of the retina was produced for one moment only*, and was so inconsiderable as easily to escape notice. Afterwards the current went on as usual. The same result was produced by deligation (temporary or permanent) of both carotids in dogs. In two rabbits, similarly treated, there was *no* interruption of the current of the central artery of the retina, and consequently no bleaching of the

fundus. This led to the suspicion that the sources of supply to the eyes were through the vertebral arteries. In two dogs, therefore, the innominate artery was tied (this, in dogs, gives off the two carotids, and the right subclavian with the corresponding vertebral). A loop was then cast round the left subclavian, below the origin of the left vertebral. It was found that the left vertebral alone was sufficient to maintain the ocular blood supply undiminished; but when this artery was closed by tightening the loop below its origin, the eyes became quite bloodless. When the loop was relaxed, the vessels began slowly and gradually to refill.

As a general rule, the hæmostatics of the rabbit's eye were influenced with difficulty. In young dogs, on the contrary, the ligature of one carotid was sufficient to produce pallor of the corresponding fundus, lasting perhaps half a minute.

There seemed more interest in similar experiments upon the veins; since the author hoped to obtain some proof of the soundness of Donders' very probable hypothesis about the relations between the ciliary and the retinal systems. In dogs and rabbits the veins are very well placed for such experiments. The anterior facial vein, the immediate continuation of the external jugular, passes from the neck to the chin, over the edge of the lower jaw, along the border of the masseter, to the orbit, and dips into the orbit, after winding round its inferior margin. It then ascends along the inner margin of the orbit to the brow, and passes on to the nose, where it unites with the vein of the other side. On entering the orbit it receives a branch that comes from the base of the skull, through the optic foramen, along the posterior wall of the orbit. Into this branch open the ciliary veins, that perforate the posterior segment of the sclera. In the course of the anterior facial along the inner and anterior wall of the orbit, it receives the ciliary veins that perforate the sclera on the same side. Veins proceeding from the outer side of the eye unite directly with the temporal vein, so that all the ciliary veins in these animals are parts of the external jugular system. The central vein of the retina opens into the cavernous sinus.

It is therefore possible to arrest the flow of blood in the veins of the ciliary system without interfering with the flow in the retinal system; and, according to the hypothesis, an increase in the blood of the first system would be attended by a diminution of the blood in the second.

A loop was put around one of the external jugular veins (both in dogs and rabbits the same results were obtained), and was kept tight from a few seconds to a minute. Instead of the expected emptying of the retinal veins, not the slightest change in them was produced. In rabbits the vessels of the choroid and the colour of the fundus remained unaltered. Attributing this to the free anastomosis between the veins of the two sides, the

author tied both of them at the same moment. The result was still negative. Doubting the correctness of his anatomical researches, and supposing that some of the ciliary veins might open into the internal jugular, the author tied all four jugular veins at once. The intraocular appearances still underwent no change. The next experiment was an endeavour to tie the spinal veins; and this failing, a loop was thrown around the upper extremity of the superior cava of a dog, and all descent of blood from the head at once arrested. The loop was kept tight for a minute, and neither at the time of tightening, nor during the period of constriction, nor when the loop was relaxed, was there the slightest change in the diameter or fulness of the central vessels. The experiment was repeated on a white rabbit, with the same result; and the author concludes *that the eye is a sphere filled with fluid in such a manner that the pressure exercised upon it by the complete arrest of its venous current does not suffice to render it any fuller than before.* He is of opinion that this fact is of great physiological and pathological importance. It proves, first, that the structure of the eye is concerned in the regulation of its circulation; and, secondly, that hyperæmia of any of the vitreous membranes, apart from prior or simultaneous pathological change —purely mechanical hyperæmia—is an impossibility.

In order to establish this fact with scientific certainty it is necessary to determine the conditions on which it rests, and also to set aside some objections. The fact itself must depend upon the anatomical conditions of the ocular system of vessels, and upon the physical peculiarities of the ocular textures. The choroidal vascular system contains in itself all the conditions of a regular circulation, and is imbedded in a peculiar stroma of elastic tissue, which closely surrounds the vessels. Upon the function of this stroma nothing has been hitherto made known. It appears that one of its objects may be to retain the vessels at a certain diameter.

The choroidal system and the other ocular membranes are subject to the continual influence of two forces, that act in opposite directions—on the one side the equable outward pressure of the ocular fluids, on the other the inward pressure of the sclerotic. Consequently the possibility of adding to the fluid contents of the eyeball must depend upon two circumstances—either upon the elasticity of the ocular fluids, or upon the yielding of the sclerotic. With regard to the fluid contents, it may be affirmed, *à priori*, that they offer complete resistance to the pressure occasioned by the foregoing experiments; and the water that forms 99 per cent. of their bulk possesses a degree of elasticity so small as to be inappreciable. Donders has shewn that the sclerotic is almost inextensible under any pressure to which it can be normally subjected; and the author's own experiments would shew that it is wholly inextensible. It will now be intelligible

how the regulation of the circulation of the eye is effected. *It is by the relation of interdependence between the tension of the ocular fluids (which, on its side, depends upon the endosmotic equilibrium between those fluids and the blood) and the tension of the sclerotic.*

On physiological grounds, indeed, the fact could not well be otherwise. The harmony of the opposition between the ocular fluids and the sclerotic is necessary, in order that the excessively delicate function of accommodation may be freely discharged. This function would soon and greatly suffer if the eye contained sometimes more blood, and sometimes less. Pathology teaches how considerable a disturbance of accommodation is produced when only the slightest derangement of the counter-working of the two forces exists. With the first appearance of glaucoma the eye loses its power of accommodation, the iris becomes immovable, the ciliary muscle paralysed, the eye presbyopic.

Proceeding to the phenomena that appear to contravene his position, the author mentions that, in eyes in which the intraocular pressure is increased, pulsation of the veins, or even of the arteries, occurs. Concerning the cause of this pulsation, all authors are nearly of one mind. The pulse depends upon the momentary increase of intraocular pressure during the arterial diastole, and upon its decrease during the systole. To this Donders adds that the pulse, which is very evident in tense eyes, exists in normal eyes also in a small degree. He discovered this by observing the fundus oculi under higher magnifying powers than had been used by Coccius and van Trigt, the discoverers of the venous pulse; and his statements have been fully confirmed. In fact, in every healthy eye, there are regular oscillations of tension, and these only become pathological when they pass a certain limit.

The experiments already detailed shew that interruption of the venous current is insufficient to produce any increased pressure, or any venous pulse. It has never been observed that, in any case in which only an increased pressure of blood was suspected, an increased pulsation corresponding to the hyperæmia has occurred: the pulse only comes into prominence when transudation preponderates over absorption within the eye. The question thence arises whether, in previously balanced conditions of diffusion, the interruption of the venous current in the neck would not increase the rapidity of the exosmotic blood stream. An absolute answer to this question cannot be given; but in a series of experiments tried by the author, it was not found that ligature of the jugular veins at all increased the rapidity with which salts injected into the veins appeared in the aqueous humour. It is well known as a pathological fact that impediments to the venous current promote watery transudation. That such transudation did not occur in the experiments may be explained as follows:—First, it is very doubtful whether the rapidity of the watery dif-

fusion would be increased in so short a time as that for which the ligatures were tied. Experience teaches that the secretion of aqueous humour, *e.g.*, after paracentesis, does not take place so rapidly. Some hours are usually required before the eye returns to its normal tension. Secondly, supposing that the fluids in the eye increased during the momentary arrest of the venous current, yet this increase would be extremely small, and would first influence the vessels; that is, it would force back a corresponding quantity of blood into them. The blood would either be delivered in smaller quantity by the arteries, or it would be forced into the veins, very yielding channels, although for the moment closed. From all this it follows that the diameter of the vessels is diminished, by the increased exit of fluids from the eye, in the same degree that it is increased by the venous stasis; so that the intraocular pressure remains the same, after deligation of the veins, as it was before. Hence the pulse is not so much the proper expression of the oscillations of intraocular tension, as of the above mentioned mechanical faculty of blood regulation in the eye; by which, in the same degree that the pressure is increased by the arterial diastole, it is diminished by the simultaneously increased outflow through the veins. The intraocular pressure in the normal eye thus remains always the same, and the faculty of blood regulation governs not only the hæmostatics, but also the intraocular tension.

A second objection seems to rest upon the phenomenon observed by Ludwig and K. Weber in the following experiment. When the manometer tube was introduced through the cornea into the eye of an animal, the mercury in the tube was thrown into oscillations by each stroke of the heart and each respiratory movement. The observers inferred from this that the vessels of the normal eye expanded at the moment of expiration, and contracted at inspiration, as at the stroke of the heart. The experiment was entirely vitiated by the perforation of the cornea, which destroyed the natural harmony between the ocular fluids and membranes. If in the normal eye there were to-and-fro movements of the membranes on the surfaces of which images are received, no distinct vision would be possible. The fact that the quantity of blood within the eye remains always the same allows the visual function to be carried on without hindrance from the circulation; and any wound of the coats of the eyeball that diminishes the support afforded to the ocular blood-vessels, is followed by their distension, even to such a degree that they may burst, and produce retinal hæmorrhage. In a dog that died during experiment, I observed that, on suspending it head downwards for some minutes, there was no enlargement of the retinal veins. On suspending it by the ears it was manifest that the blood obeyed the action of gravity, and flowed away from the eyes. The cornea was punctured, and the experiment

repeated; and then, on hanging the dog head downwards, the ocular vessels become considerably distended, both in the retina and on the disc. In this experiment all vital influence was set aside, and the result absolutely proved the mechanical regulation of the ocular circulation.

It has been often observed by medical jurists, in persons killed by hanging, that Schlemm's canal was distended with blood. This is easily to be explained, since Schlemm's canal lies in the thickness of the sclerotic, and the blood within it is subject to a totally different pressure from that within the eye. Jurists have never observed distension of the veins of the iris, although they open directly into Schlemm's canal.

In conclusion, it is suggested that the measurement, by a manometer, of the different pressure in the ligatured and the normal veins, may afford a means of estimating, very nearly, the normal pressure within the eye.

OPHTHALMIA AFTER INJURY; CONSECUTIVE CATARACT; CONFLICTING MEDICO-LEGAL OPINIONS.

By Dr. Ragaine (*Journal de Brux*, xxxviii, p. 27, Janv., 1864; *Dr. Geissler, in Schmidt's Jahrbücher*, Bd. 127, p. 211).

A SERVANT girl, 19 years old, professed to have received a blow on the right eye from the head of a man who had embraced her. She stated that she was menstruating profusely at the time, that the menses ceased, that inflammation and acute pain commenced in the eye, and increased in three days so much as to be insupportable, being attended by photobia and lacrymation. She kept the eye bound up, and in the second week, on account of increasing pain, withdrew herself from household work. In the third week she applied for the first time to a surgeon, who ordered ten leeches to the temple, seidlitz water, and a blister to the nape of the neck. No improvement followed, and the left eye became irritated. In the tenth week after the injury the patient came to hospital. In the right eye the lids were slightly swollen and reddened, there was much intolerance of light and lacrymation, acute injection of the palpebral and ocular conjunctiva, and also of the anterior ciliary vessels, which were brought into view when the conjunctival vessels were emptied by digital pressure. There was an ashy grey opacity of the cornea, especially in the centre, where it had the appearance of glass dimmed by the breath. The pupil was much contracted. In the left eye there were also symptoms of kerato-iritis, although the cornea was less turbid, and the pupil not so narrow. Vision could not be tested on account of the photophobia. The general condition was normal,

and the repressed menses had reappeared. Pulse 80, appetite and sleep indifferent. In hospital the case was treated by repeated local antiphlogistics (instillations of atropine, mustard footbaths, inunctions of mercurial ointment with belladonna). Internally, mercurials and antimonials, with occasional laxatives and opiates. Lastly, blisters were applied to the nape of the neck. In a day or two the pain was relieved, and the pupil dilated. In 45 days the inflammation of both eyes had quite disappeared, but in the right only there remained a small corneal opacity. The patient was then discharged, but it was specially dwelt upon, by the witnesses opposed to the belief that the ophthalmia was of traumatic origin, that the eye then still required the greatest care for a month or two, on account of possible sequelæ.

In 26 days after the patient was discharged, $4\frac{1}{2}$ months after the injury, the opacity of the right cornea had entirely disappeared. 14 days later the patient perceived a whitish mist or cloud before the right eye, which increased so quickly that in three weeks she could only distinguish light from darkness. After dilatation of the pupil, opacity of the anterior layers of the lens was discovered. On the nasal side a portion still remained transparent.

In medical opinions it was suggested that the cataract, being one-sided, and no fresh morbid influence having been in action, could only be referred to the injury; and it was assumed, from the slow progress of the opacity, that the capsule had not been ruptured. Moreover, on account of the slight corneal turbidity, the commencing changes in the lens might easily have been overlooked when the patient was discharged.

The surgeon who had first attended the case, three weeks after the blow, was questioned by the court. He denied that the inflammation had been produced by the blow, on the ground that no mark of the latter was visible on the cheek, neither was there any injection of the conjunctiva or episclera. He found only a facetted ulcer in the middle of the lower half of the cornea, with no swelling of its margins. The posterior layers of the cornea were somewhat turbid, the iris had a reddish aspect, and there was a small quantity of pus in the anterior chamber. This witness believed that the inflammation, as he saw it, had existed for only four or five days at the outside; but he could not assign (excluding the blow) any other reason for its occurrence. The hospital surgeon opposed (Dr. Geissler thinks rightly) the opinion of his predecessor. The absence of direct marks of a blow on the cheek, three weeks after its infliction, proved nothing, since such marks in healthy people would seldom last so long. The belief that the inflammation of the cornea was idiopathic was not supported by experience; and ulcers and turbidity of the posterior corneal layers with hypopyon, must be taken as results of an irritation of more than four or five days' continuance.

Dr. Ragaine does not state the decision at which the court arrived. In the few forensic cases of eye injury on record, the foregoing is not without interest; but the influence of the arrest of the menses was probably considerable.

TEST LINES FOR THE DETERMINATION OF ASTIGMATISM.

By Dr. John Green, of Boston, U. S. (Zevende Jaarlijksch verslag omtrent de verpleging en het onderwijs in het Nederlandsch Gasthuis voor Ooglijders.)

[(Note by Prof. Donders.) Dr. John Green attended for some time the practice of the Netherlands Hospital for Eye Disease, and found opportunity to prepare these test lines, and to have them lithographed.]

These test lines are given in three plates, and are intended to facilitate the recognition of astigmatism.

In use they are to be placed at a distance of from ten to twenty Paris feet. At this distance the accommodation of an emmetropic or a myopic eye is relaxed, and the pupil rendered much larger than in accommodation for a short distance. With a large pupil the refraction is determined over a large part of the cornea.

The test lines in Plate I. are formed from a set of three equal lines, precisely like those already given by Snellen with his test types, as No. XX. The thickness of each line, and of the interval between each two lines, appears, at a distance of twenty feet, under a visual angle of one minute. The set of three lines appears under an angle of five minutes. Twelve sets of these three-fold lines are placed as radii passing through the centre of a circle, about a foot in diameter, and at an angle of thirty degrees from one another. Each set of lines is numbered, from I. to XII., in the same way as the dial of a clock. The whole star of lines may be drawn upon cardboard, and made to turn upon a central pin, so that it will be easy to make any set coincide exactly with the meridian of clearest vision.

In the application of this arrangement to the recognition of astigmatism, it is only necessary to ask the patient whether, at from ten to twenty feet distance, he sees one set of lines better than another. For this purpose it is sometimes necessary to correct an evident ametropia by spherical glasses; and it is perhaps best to select glasses that produce a slight degree of myopia. In case, then, the patient, at the greatest distance for clear vision, sees the sets of lines with different degrees of distinctness, the existence of astigmatism is shown, and the direction of the meridian of greatest refraction is at the same time declared.

In order now to determine the *degree* of astigmatism, it is desirable to exchange the star-shaped figure for a single set of three lines (Plate II), since otherwise the patient would have difficulty in keeping his attention fixed in the same direction. This single set must be placed in the direction of clearest vision, and the refraction determined by common spherical glasses. The card must then be turned on its axis, so as to give the lines a direction at right angles to the first, and the refraction tested again. The strongest positive glasses, through which the lines in the last position are clearly seen, express the degree of hypermetropia; the weakest negative glasses that are chosen convey the degree of myopia. The difference of refraction in the two directions, at right angles to one another, is the difference in the two chief meridians; that is, the degree of astigmatism. This determination can then be tested by the star-figure, which should be looked at by the patient through that cylindrical lens that corresponds to the degree of astigmatism discovered. This testing is not without importance, especially in hypermetropes, since they often find it difficult, especially in looking at single lines, completely to relax their accommodation. This difficulty is, however, diminished, since it is usual, before the testing, to paralyse the accommodation by the instillation of atropine.

Plate III contains another star-shaped figure, formed of sixty single lines, separated from each other by equal angles. The centre of this figure should be fixed from a distance by each eye separately. The figure must remain stationary, and will serve for the recognition of irregular astigmatism, since some of the lines will often be less distinct than others. It will often be evident that the different regions, corresponding to the different sectors of the lens, present a marked difference or irregularity of refraction.

Utrecht, February, 1866.

UPON THE NERVE OF ACCOMMODATION.

By Dr. D. von Trautvetter, of Kiew (*A. f. O.*, xii, 1, 95). ABSTRACT.

THE author states that the nerve of accommodation has been hitherto unknown; and sets forth the results of his experiments with a view to its discovery. He first devotes some pages to a *résumé* of the opinions of authors upon the question, and points out that the results of anatomical investigation have been negative. His own experimental researches were at first no more successful; but at last he was able to obtain positive evidence.

It is well known that, in accommodation for the near point, the eye undergoes several changes, such as contraction of the pupil, projection forwards of the pupillary margin of the iris, retraction

of the equatorial margin, and a shifting and diminution of the Sanson's image reflected from the anterior surface of the lens. The most important of these changes is the increased curvature, or projection forwards, of the anterior surface of the lens, which the change in the Sanson's image renders visible. The author used this phenomenon as the test of accommodation, and in order to determine the nerve that governs the function. He says expressly "the nerve," since his experiments shew that only a single nerve is concerned. He observed the Sanson's image reflected from the anterior surface, and irritated by turns all the nerve trunks proceeding to the eyeball. The trunk that, when irritated, produced movement and diminution of the image reflected from the anterior lens surface, the author considers to be the nerve of accommodation.

After giving very full details about the arrangement of the lights in order to get good images, about the methods of securing the animals operated upon, about the steps of the various operations, about the position of the observer, and the various precautions necessary, the author states the following results :—

1. In mammalia (dogs, cats, and rabbits), no change was produced in Sanson's images by irritation of the third nerve, of the sympathetic, or of the fifth.

2. In birds (pigeons and hens) irritation of the third nerve, and of this only, produced a marked change in the position and size of the images; leading to the conclusion that, in birds, the third is the nerve of accommodation.

3. The negative results obtained from dogs, cats, and rabbits, may be explained by supposing that, in these animals, the accommodation is either deficient, or performed in a different manner from that of men and birds. In rabbits the power is probably wanting—a view supported by the absence of muscle in the ciliary zone, which consists of connecting tissue only. In dogs and cats, the existence of the power may be inferred from the presence of a ciliary muscle; but the facts:—*a*, that the relative sizes of the reflected images are different in them from their relative sizes in men and birds; *b*, that they possess only radiating, and no circular fibres in the ciliary muscle; *c*, that in dogs the pupil dilates for near and contracts for distant vision, support the belief that in these animals the function differs in its arrangements from those of men and birds.

The paper concludes by an account of some further experiments after iridectomy, intended to show, and showing, that the ciliary muscle is the active agent in the accommodative change. In one of these experiments the cornea and iris were removed, and then electric excitation of the third nerve was followed by projection forwards of the uncovered lens. The author states positively, that the third nerve is the nerve of accommodation, and the ciliary muscle the muscle of accommodation.